Transport Canada Transports Canada

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CANADIAN AIRSPACE SYSTEMS PLAN

FACILITIES, EQUIPMENT AND ASSOCIATED DEVELOPMENT

OCT, 1983

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This document, the Canadian Airspace Systems Plan, outlines the evolutionary approach that the Administration proposes to take to meet Canada's aviation needs to the year 2000, to replace obsolete equipment and to provide an efficient and effective technical framework for the provision of services to air traffic. The Plan identifies the capital investment, the engineering and development, the acquisition programs, the strategy and the decisions required to modernize and consolidate the systems utilized in the provision of services in Canadian Airspace. Based on this Plan, a complementary document, the Canadian Airspace Review, will be developed for describing the operating procedures and airspace structures needed to exploit fully the technical framework. It is intended to update the Canadian Airspace Systems Plan periodically, to reflect the changing operating requirements.

Faced with a similar need to contain rapidly escalating operating costs, the United States Federal Aviation Administration (FAA) published, in 1982, its first ever comprehensive National Airspace System Plan. It detailed a pragmatic and impressive long-term approach to the replacement of obsolete equipment whilst providing a sound technical framework capable of accommodating all foreseeable air traffic operations. As an integral activity, the FAA is also conducting a National Airspace Review which focuses on the airspace and procedural aspects of air traffic operations.

Through an analysis and discussion with the FAA, it was evident that Canada could derive significant benefits by taking a similar approach. Such an approach would enable us to provide a clear systems and operations development strategy and total systems compatibility with the FAA.

This Systems Plan, in addition to providing a framework for the management of a complex and ever-changing system, will provide user-groups and industry with our statement of intent and will enable them to influence the evolution of our system and to formulate their plans for the future. The aviation community will be asked to examine the Plan and consult with CATA to ensure that the strategy proposed will satisfy their requirements and give the desired flexibility needed for the system to evolve over the next fifteen to twenty years.

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INTRODUCTION

The Canadian Airspace Systems Plan provides the development and integration strategy for modernizing and improving the systems of facilities and equipment utilized in the provision of services to air traffic, from now until the year 2000.

The plan addresses the issue of how best to accommodate changing demands for services, constrain costs, restructure the technical framework and deal with aging facilities.

It delineates specific improvements to facilities and equipment and supporting engineering development associated with the provision of air space services. Particular emphasis is focused on terminal and enroute air traffic control, flight services, aviation weather, ground to air systems (navigation, communications and surveillance), interfacility and intrafacility communications and auxiliary systems such as facilities maintenance and flight inspection of navigation aids.

The volume of air traffic requiring use of these systems varies geographically. Consequently, this plan recognizes and caters to two different areas of domestic airspace demand - a high density traffic area in the southern part of Canada and a low density traffic area to the north. Some growth in demand for services has been assumed, as derived from CATA's general forecast for aviation growth, as well as the forecast increase in the movement of passengers and goods contained in the National Airports Plan. The scope and capability of the Systems Plan, in terms of the technical framework of facilities and equipment required, complements the infrastructure of the National Airports Plan. Together these plans will ensure the evolution of a balanced and efficient National Air Transportation System.

The theme throughout the plan is that safety, capacity, productivity and economy will be chiefly realized through higher levels of automation, consolidation of certain facilities and services and the application of rapidly-changing technologies in telecommunications to achieve lower systems operating costs.

The scope of the Systems Plan contains improvements which offer benefits to all users of Canadian airspace. Whilst operating under the visual flight rules, light general aviation aircraft may make use of the increased coverage in communications and navigation facilities offered by the Plan, in either controlled or uncontrolled airspace. The flight information and alerting services provided to uncontrolled flights will be considerably enhanced, partly because flight planning is more likely to be carried out due to the facilitation offered and partly because of the improved dissemination of flight data, the automation of which benefits all users.

Aircraft not wishing to participate in the controlled flight environment are nevertheless provided with easy access to weather information that they specifically need. For those aircraft equipped with more sophisticated equipment, the future controlled environment will be much less restrictive due to the use of advanced levels of automation which will permit users to choose the most efficient profile and receive clearances free of bad weather and traffic conflicts.

A wide range of navigation capability will be accommodated by the plan permitting all users to maximize their own potential in the system.

The role of the air traffic service personnel will move toward that of system managers, with reliable automation carrying out the detailed data processing needed to determine clearances. Flight safety and expedition will thereby be enhanced.

The Plan includes a description of approved projects which are already underway. Their continuation within a total system strategy, along with other projects outlined in the Plan, will ensure that an integrated system of facilities and equipment will be in place in time to respond to the needs and demands of Canadian aviation and the future users of Canadian airspace.

THE PRESENT SYSTEMS

Today's systems utilized in providing airspace services are a combination of equipment, techniques, procedures and skills that have evolved over a number of years. This evolution has produced a mixture of equipment of many ages, technologies and types. The total system is as safe and efficient as any in the world, but it is very expensive to operate and maintain, has limited expansion capability and it is difficult to adapt to changing requirements.

Today's systems are characterized by:

- High operation and maintenance costs where vacuum tube type electronic equipment is in use.
- Limited capacity of the automated air traffic control system.
- Different types of computers and software languages in each air traffic control sub-system.
- Different types of controller consoles and display equipment in enroute and terminal facilities.
- Multiplicity of leased communications lines.
- Inefficient data transfer.
- Highly labor-intensive operations involving extensive supply, training and technical support resulting in low productivity and capacity in the air traffic services.
- Almost exclusive reliance on tactical air traffic control methods.

- Inflexible route structure design.

- Virtually no systems integration and no interfacility data acquisition and transfer.

- Inability to meet the demand for pre-flight aviation weather briefings.

- Limited access to real-time weather data.

- Inability to predict air traffic congestion and the subsequent need for flow mangement.

In order to overcome its deficiencies and to meet the demand for improved services, the system must be modernized. Adding more technicians, controllers, or expanding the current system in other ways, will only amplify its shortcomings. Also, this solution is wasteful, as it too requires considerable capital investment and simply postpones the problem.

PURPOSE AND SPECIFIC OBJECTIVES OF THE CANADIAN AIRSPACE SYSTEMS PLAN

The central purpose of this plan is to provide the technical framework which will permit the provision of safe and efficient services to air traffic. The operation of the system to meet this central purpose must itself be efficient. Specific objectives include:

- Having an operating National Airspace System in place to meet the demand at the time it is required.

- Accommodating increasing demand in a way that allows users of the airspace to operate with a minimum of artificial constraints and with increasing fuel efficiency.

- Reducing risks of midair and surface traffic collision, landing and weather related accidents, and collisions with the ground.

- Increasing the productivity of air traffic controllers and flight service specialists.

- Minimizing the number of technical staff required to maintain and operate the modernized and expanded system.

- Maximizing the return on the capital investment through a reduction in operating and maintenance costs of services to air traffic.

The contents of this Systems Plan reflect the best judgement about what is required to meet the above objectives. The Plan takes a total systems approach and is flexible enough to:

- Accommodate future demands and technology.
- Improve safety services.
- Increase productivity.
- Constrain costs.
- Permit a national system evolution.
- Minimize restrictions to users.

ASSUMPTIONS

The Systems Plan is based on the following assumptions:

- System changes will be necessary, flexible enough to accommodate foreseeable air traffic growth and changing demands for services.
- The right of access to Canadian airpsace by any class of user should not be constrained unnecessarily.
- In order to operate in designated airspace specific avionics equipment may be required in the interest of all users of that airspace.
- Individual user's preferences for routes, runways, approaches, altitudes, etc., will be honored unless they cause delays to other users.
- No change to the system will be permitted which reduces safety or increases risk. A very high level of mid-air collision avoidance assurance will be afforded by the ground based system. Back-up, ground-independent, airborne separation devices provided by the user, will be accommodated.
- No new major air-carrier airports are planned within the time frame of system implementation. Where physical expansion is limited, additional capacity will be achieved primarily through a reduction in separation minima resulting from technological advances, refinements in ATC procedures and through runway, terminal and access improvements.
- Fuel costs will continue to be a major portion of airline operating costs.
- Costs associated with the construction of buildings are not included in the capital requirements.

THE STRUCTURE OF THE PLAN

Following this overview, Chapter 2 provides a review of the demands on the system. Chapters 3 to 8 contain narrative descriptions of the components of the current system and their evolution through the near term (to 1985), intermediate term (to 1990), and long term (to 2000). The evolution is also shown in diagrams which indicate the relationships among programs and systems.

The description is further illustrated by a series of maps depicting changes in equipment locations in each of the "snapshot" years: 1982, 1990, and 2000. This is followed by a short discussion, indicating the benefits of the plan. The remaining portion of each chapter provides a description of the major Facilities and Equipment (F & E) programs and Engineering Development (ED) programs supporting these elements or leading to the acquisition of systems, equipment or software. Projects within each program provide the purpose of the project, the approach to be taken to meet a specific need, the quantities being acquired, and a listing of related projects. Following these are two charts depicting the schedules or major milestones to be met, both for Facilities and Equipment and Engineering Development portions of the project.

It should be noted that, although specific locations could be assumed for facilities marked on the maps in the technical chapters and specific time frames are provided for project development on the evolution charts and project sheets, these are representative of likely locations and likely dates as perceived in the current strategy. Project approval, specific locations and planning dates will be determined when each program is put forward in the normal departmental programming process. Therefore, the Canadian Airspace Systems Plan represents the strategy for implementation of the future systems needed. The strategy can change, arising from future needs, with constant surveillance of projects being made to ensure that the requirements for integration are satisfied.

HIGHLIGHTS OF THE PLAN

AIR TRAFFIC CONTROL - ENROUTE AND TERMINAL

Canada's Air Traffic Control (ATC) organization is responsible for providing control and advisory services in national and international (oceanic) airspace. Services are provided from Area Control Centres (ACC's), Terminal Control Units (TCU's), and Towers (TWR's). With regard to the facilities and equipment required for the ATC System, the plan emphasises the following important aspects:

- Extended use of automation in order to enable a greater strategic control capability, including conflict prediction and resolution.
- The use of common controller workstations (sector suites), with common modular hardware, and software based on the use of a high level language.
- Air-ground data-link for automatic two-way transfer of information (clearances, weather, etc.).

Emphasis on these aspects are aimed at maintaining a high level of safety, imposing a minimum of constraint on users, improving controller productivity, improving fuel efficiency, and reducing operating costs.

The systems and equipment used in ATC facilites will be standardized, with most hardware and software elements being identical. The computer systems and controller workstations (sector suites) both for the ACC'S and TCU'S will be the same except for the capacity of the computers. To the maximum extent practicable TWR'S will use the same equipment.

A distributed processing approach to data management will continue to be the basis of the ATC System Design. Central processors, such as the Flight Data Processing System and the Aeronautical Information Processing System, will support large data bases (accessible by all ATS facilities) and carry out major processing functions.

The sector suites will provide a new environment in which air traffic controllers will be able to function more efficiently and effectively. Each suite will contain redundant microprocessors and the digital displays will be functionally interchangeable. Tactical data (plan view traffic situation), will be displayed, as well as supplementary aviation information. Additionally, strategic displays will indicate flight plan data (replacing the current flight strips). Planning/probing displays will be used for indication conflict-free, fuel-efficient flight profiles.

The sector suite processors will select required surveillance, flight data and weather information from distribution networks and process data necessary for the particular controller posiltion. If a central processor fails, the sector suite processors will be able to provide essential service by utilizing information available on distribution networks, combined with that maintained in local data bases.

The distributed processing and network techniques inherently provide high availability and protection from total system failure. Increased operational flexibility can be achieved, since the number of controller operating positions can be reconfigured to meet changing demand based on day-to-day or hour-to-hour workload considerations. When traffic decreases, controller suites and associated communications can be configured into larger operating sectors and the total number of operating positions and associated staffing can be reduced.

System standardization techniques will establish a series of automation, display and communications systems that provide a wide range of benefits and cost reductions. Common systems require lower investment in development and procurement. Additionally, due to the commonality of operations and maintenance, engineering and staff support, logistics and training support, their life-cycle costs are reduced.

FLIGHT SERVICE SYSTEM

The flight service system encompasses all those services and facilities which provide information and advice to assist the pilot in the planning and conduct of his flight. The provision of such information is a primary responsibility of the Flight Service Station (FSS).

This chapter of the Plan details the following major areas of development in flight service systems.

- Modernization of Flight Service Stations and the application of automation techniques, such as automated weather observing and reporting systems, direct user access terminals and remote communications outlets will permit consolidation of facilities to approximately 26 HUB Stations by the year 2000 and a reduction in overall operating costs.

- Taking advantage of state-of-the-art technology, as it applies to FSS workstations, will increase Flight Service Specialists' productivity and improve system efficiency, reliability and availability.

- A significant improvement in flight planning and aeronautical information service to the pilot will be achieved through introduction of direct access, "one-stop" service for flight plan filing, notices to airmen (NOTAM), weather, and the aids status of airports and navigation.

- Both quality and timeliness of flight information will be improved through an upgraded aeronautical fixed telecommunications network with additional capacity providing more up to date data banks.

- Inflight access to weather information will be enhanced through the establishment of an enroute weather advisory service operating on a common frequency.

Flight planning efficiency will increase with the pilot's ability to access directly flight planning information without assistance from flight service specialists. This information will be provided by regional aviation weather and aeronautical data bases. Modernization of the flight service system will be accelerated over the next 15 years to enable consolidation of Flight Service Stations and to realize the operating and cost benefits of automation.

AVIATION WEATHER SYSTEM

Provision of accurate and timely weather information is essential for the planning and conduct of safe and efficient flight. The main source of weather data is through manual observations. These data are collected and processed into aviation weather forecasts by the Atmospheric Environment Services (AES). Weather forecasts are disseminated to users by various means, such as by telephone and personal (one-on-one) contact with weather briefing specialists. This labour intensive means of weather observations and dissemination is inefficient and not cost effective.

To provide improved access to aviation weather information, the major thrust in the plan for Aviation Weather Systems is in the application of automation. Priority will be given to the following:

- Automatic Weather Observing and Reporting Systems (AWORS). About 300 systems will be implemented to provide increased observations from all areas of Canada.

- The quality of aviation weather forecasts will be improved through the provision of greater coverage, by more numerous observations available through the AWORS, and by integrating weather data from other sources such as radars and satellites.

- Dissemination of weather data will be improved by providing users direct access to CATA regional aviation weather processors. User-friendly and easily interpretable terminals will be the principal means of access to the most up-to-date weather data.

Action required by the pilot to obtain appropriate weather for his flight will be streamlined. In geographical areas where a high volume of general aviation (such as flight training or pleasure flying) is prevalent, mass dissemination of aviation weather information will be introduced. Either commercial cable or dedicated TV terminals, through computerization, will display aviation weather data graphically in an easily interpreted format. Development of CATA aviation weather processors connected with the AES central computer will enable the routing and processing of data, obtained from the large numbers of automatic weather observing and reporting stations through to the automated display terminals used by FSS briefers and air traffic controllers. Eventually these terminals will be developed into direct user access terminals. This will permit the pilot to access the aviation weather data to select a flight profile optimized for existing weather conditions, and subsequently to file his flight plan.

Strategic air traffic control, whereby advanced optimization of flight profiles will be effected, will be facilitated by the provision of accurate wind vectors by the new weather processors.

In areas of high-density traffic, a combination of AES, DND and TC radars will provide effective weather coverage of routes in the lower altitudes and volumetric coverage at 18,000 feet and above. FSS workstations will also utilize the radar and satellite data to provide preflight and inflight weather advisory service.

GROUND TO AIR SYSTEM

Ground-to-air systems include enroute and landing navigation systems, surveillance systems and communication systems. The major developments in ground-to-air systems outlined in the plan emphasize the following:

- Completion of modernization programs to eliminate older tube type equipments in order to obtain reliability at lower operating costs.

- Introduction of remote maintenance monitoring concepts and equipments so that travel to remote sites can be reduced and equipment conditions can be determined and corrected from central maintenance locations.

- Consolidation of facility locations to minimize the requirements for real estate, reduce maintenance costs and integrate coverage volumes provided by navigation, surveillance and communication installations.

- Implementation of new systems such as Mode S secondary surveillance radar with data link, Microwave Landing System (MLS) and satellite/HF data link which will improve the capability of the system to absorb additional traffic levels safely and efficiently while maintaining or reducing operating and maintenance costs.

- The different solutions required to meet the different needs within the Canadian environment between high and low areas of traffic demand.

Surveillance systems development will see the replacement of all existing radar systems, both primary and secondary, and the incorporation of Mode S data link in the enroute secondary surveillance radars. The weather surveillance data provided by the primary ATC radars will be combined with dedicated weather radars to improve the real time weather picture for pilots, controllers and flight service specialists. Total coverage by these systems will be provided in the high density traffic area at and above 18,000 ft. and in heavily utilized areas at and above 12,500 ft. Below these altitudes coverage will be available along airways and in terminal control areas. In low density traffic areas, at and above 18,000 ft., surveillance will be provided by relaying airborne derived navigational information via a satellite/HF data link.

Navigation systems developments will see the completion of a VOR-DME network which will ensure that navigational coverage is consistent with the coverage provided by surveillance radars in the high density traffic area. Similar coverage from communications systems and VHF direction finders will be available. Outside of radar coverage in the low density traffic area a network of DME's collocated with NDB's will provide for DME updating of airborne inertial navigation systems as well as improving navigation for aircraft flying at lower altitudes. Increased use of Omega will be encouraged by supplementing coverage with one or two VLF stations and differential Omega will be installed at selected locations. The concept of minimum navigation performance standards for operations at and above 18,000 ft. in the low density traffic area will be adopted.

Landing systems development will see the complete replacement of the Instrument Landing System (ILS) by MLS by the end of the period and the implementaion of category III operations at a small number of the busier airports. Withdrawal of ILS service will begin soon after the ICAO protection date of 1995 and be complete by the year 2000. Existing non-precision approach systems will continue to be utilized and will be supplemented by DME and differential Omega at selected locations. As ILS is withdrawn from service the locator NDB's will be retained to preserve the non-precision approach on that runway.

Communication improvements will focus on replacing obsolete vacuum tube type equipment with solid-state technology. Additional communication facilities will be provided, particularly in northern areas. Installation of remote maintenance monitoring for communication systems and conversion of communications equipment to 25 kHz channel spacing capability will be completed. High frequency (HF) communication facilities will be converted to solid-state. Total VHF communication coverage at 12,500 feet and above in the high density traffic area will be completed. Consolidation of compatible communications, navigation and radar equipment into common buildings will be carried out where cost savings and improved reliability can be achieved.

Engineering development work will be carried out to establish the potential of satellites for navigation, communications and surveillance purposes.

INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEM

Interfacility systems provide voice and data communications between air navigation and air traffic service facilities. Intrafacility systems provide voice and data communications within ATS facilities.

The plan emphasizes the following important aspects.

- A Canadian Aeronautical Digital Network (CADIN) will be established. It will interface with the FAA National Automated Data Interchange Network (NADIN) as well as with the Common ICAO Data Interchange System (CIDIN).

- A mix of owned or leased, terrestrial and satellite communications techniques will be utilized.

- The system will take advantage of rapidly changing and lower cost technologies in telecommunications.

- The system will be characterized by a rationalized, reliable, efficient network. It will use state-of-the-art technology, multiplexing, automatic switching, alternate routing, high speed digital transfer and trunking.

- Replacement of costly single user communications systems with a total network will provide significant operating cost reductions.

- Fully integrated local area networks will be established within Air Traffic Service facilities.

The present basic data communications system for Air Traffic Services is the Automated Data Interchange System (ADIS), a low speed teletype network controlled by a central message switch. The ADIS is part of the Aeronautical Fixed Telecommuications Network (AFTN) with international links. Initially, the ADIS switch will be replaced allowing for the introduction of other types of data and higher speed lines. The system will evolve to include all data needs of Air Traffic Services. Further evolution will involve the digitization of voice and the installation of smaller switching nodes in each Flight Information Region to complement the central switch. By the end of the planning period, voice and data communications will be fully integrated into a digitized total system called CADIN.

MAINTENANCE & SUPPORT SYSTEMS

Maintenance and Support systems include those auxiliary systems which are necessary for ensuring the continuing evolution, operation and performance of the Canadian Airspace System. The plan indicates the developments which will take place in the fields of flight inspection, maintenance, training, security and technical support.

The plan emphasises the following important aspects in which substantial cost-savings will be realized.

- Introduction of automated airborne equipment and new aircraft will allow for flight-evaluation of ground facilities under all weather conditions and with significantly improved efficiency.

- New, reliable solid-state equipment will require less maintenance. Its stability and performance predictibility will permit application of improved maintenance procedures.

- Modern computer technology will permit the introduction of Remote Maintenance Monitoring Systems, enabling the monitoring and analysis of the performance of equipment to be carried out from central locations.

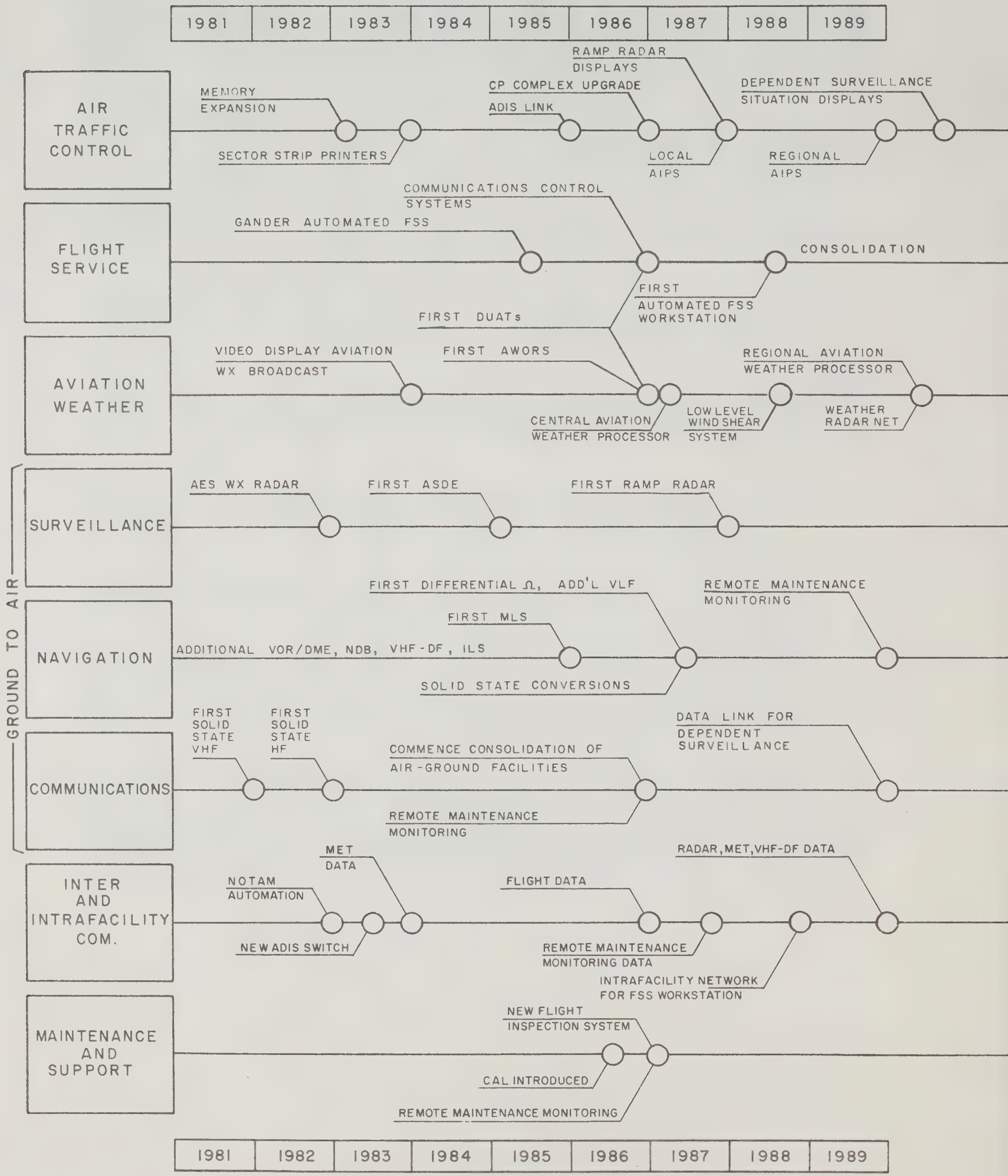
- Computer Assisted Learning techniques will be introduced in the field for the training of operation and maintenance personnel, thus minimizing training costs.

- To accomodate engineering development and field support a Technical Systems Centre will be established, enabling common services and equipment to be shared and used more effectively.

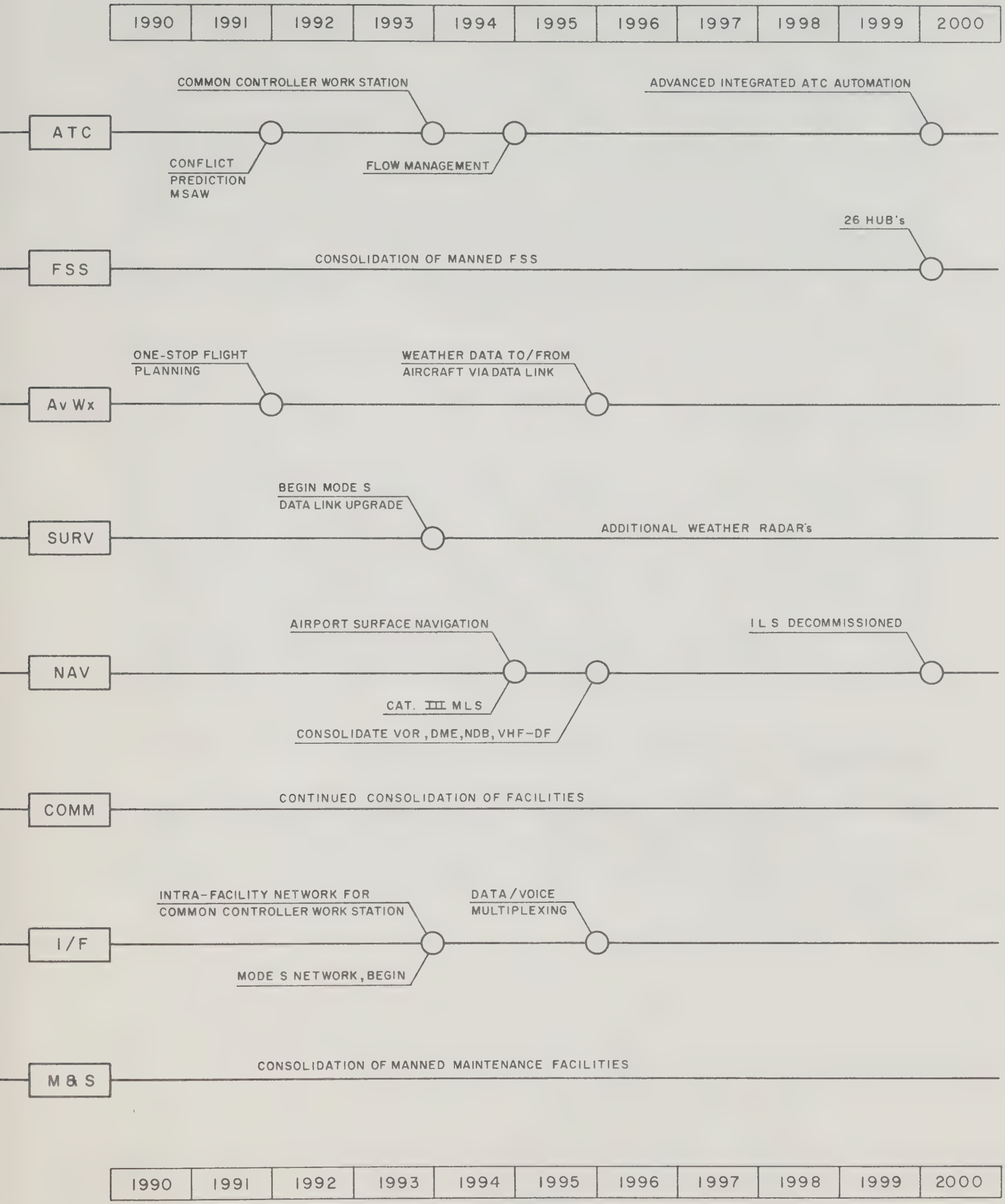
- A Management Information System will be developed and used to monitor the long-term performance of systems. By application of trend analysis, procedures and methods will be updated to maximize the efficiency and effectiveness of maintenance.

The introduction of the foregoing changes will increase the efficiency of evaluating and maintaining the Canadian Airspace System. Equipment improvements and the use of state-of-the-art computer-based technology will improve the reliability and availability of equipment and minimize the growth in person years required for operations and maintenance.

SYSTEMS EVOLUTION



SYSTEMS EVOLUTION



BENEFITS OF THE PLAN

The implementation of the Plan is expected to achieve the following:

OPERATIONAL CAPABILITY

The resulting system will consistently meet user-demand for planned, conflict-free, fuel-efficient flight profiles. Flight operations with a minimum of constraint and with the highest practicable fuel-efficiency will characterize the system. Dynamic flow management will reduce airborne delays. Safety will be enhanced through the application of automation techniques and systems redundancy.

Pertinent current weather information will be available both to the pilot, controller and flight service specialist.

Automation will minimize requirements for operations personnel.

TECHNICAL CAPABILITY

Automation, navigation, surveillance, and landing system equipment will employ state-of-the-art technology. Unique equipment types at air traffic service facilities will be eliminated and the logical grouping of compatible functions with standardized communications, computer and display elements will be used where practicable to achieve efficiency and economy. An efficient communications network will support individual facilities. Costs will be reduced through consolidation and automation of Flight Services and, whenever practicable, through consolidation of navigation, communications and surveillance facilities. Reduced maintenance will minimize requirements for maintenance personnel.

PRODUCTIVITY

The Plan will achieve improvements in the productivity of personnel. Due to the consolidation of some facilities, the implementation of solid-state equipment and increased levels of automation, the overall staff requirements by the year 2000 will be held at about the same level as today. Overall operating and maintenance costs will be similarly held at today's level.

SAVINGS TO THE USER

Implementation of the Plan will result in improved cost-effectiveness of the Canadian Airspace System. Savings to users will result from enhanced flight safety, a reduction in delays and improved fuel-efficient pilot-preferred routing. A study has already shown that the total operating cost savings to Canadian commercial carriers operating domestically on stage lengths of 400 nautical miles or more, if granted optimum routes in 1982, would have amounted to $10.5 million. The commercial traffic overflying Canada would have realized a saving of $28.8 million in 1982.

As the improvements detailed in the Systems Plan begin to take effect, evolving towards the final goal of granting optimum ATC clearances, the user of the system will begin to realize substantial savings proportionate to the degree of implementation of the Plan.

CAPITAL REQUIREMENTS

Over the past 15 years considerable expansion of the existing equipment base has been necessary to keep pace with increasing demand. Although some upgrading and replacement has been carried out most of the equipment base is in need of replacement. To meet projected user demands whilst ensuring that there is no reduction in service, a large amount of capital will be required to upgrade and modernize facilities and equipment of the Canadian Airspace System. While these capital expenditures will be necessary with or without the plan, the total integrated systems engineering approach presented in this plan will ensure maximization of benefits both for the Air Administration and the users.

A capital expenditure of $2.8 billion (1982 dollars) to the year 2000 is identified under this plan, and allocated as follows:

Radar Modernization Project (RAMP)	\$ 0.7 Billion
Microwave Landing System (MLS)	\$ 0.2 Billion
Aviation Weather Systems	\$ 0.5 Billion
Communications, Data Link and Integrated Networks	\$ 0.5 Billion
Automation and Radar Data Processing	\$ 0.2 Billion
Flight Data Processing System	\$ 0.15 Billion
Flight Service Stations	\$ 0.2 Billion
Flight Calibration (Aircraft & Facilities)	\$ 0.1 Billion
Remote Monitoring & Control	\$ 0.1 Billion
Navigation Aids	\$ 0.15 Billion
TOTAL	\$ 2.8 Billion

EXPENDITURE SCHEDULE

83/84	84/85	85/86	86/87	87/88	88/89	Future 11 Years	Total
47	83	146	200	194	182	1,948	2,800

All figures x $1,000,000

Major expenditures in RAMP, MLS, and Flight Data Processing are scheduled during 1985 - 1989. Replacement programs for navigational aids and other systems installed in the 1970s will be required in the 1990 period.

THE PLAN AND TECHNOLOGY-BASED OPTIONS

GENERAL

The critical question in developing the Plan was not which technology could be applied but which technology should be applied considering that changes would have to be made in an evolutionary manner and in accordance with the objectives of achieving economy, increasing productivity and providing adequate capacity, without degrading safety.

As the Plan shows, to meet the above objectives it will be necessary to introduce more automation, integrate systems and where possible consolidate some facilities. In the case of ground to air systems, that is, the systems which address the functions of navigation, surveillance and communications, a comparison of space-based and terrestrial techologies was carried out and is summarized below.

It should be noted that ICAO is establishing a Special Technical Committee of Council to develop a projection of international civil aviation air navigation requirements covering the period of the order of twenty-five years. In effect, the Canadian Airspace Systems Plan and ICAO's initiative are complementary.

Ground to Air - Space Technology Options

Following the termination of the AEROSAT (AEROnautical SATellite Program), an international body known as the Aviation Review Committee (ARC) completed a report in 1982 concerning, amongst other matters, the strategy for the use of space technology for civil aivation. The report concluded that owing to the high cost of dedicated satellites for communications, the use of shared satellites was the preferred economic option for civil aviation in the foreseeable future (to 2005).

Based on the ARC Report, and in appreciation of international and United States plans, the Canadian Airspace Systems Plan considered options for the potential application of satellites for civil aviation in the context of 3 basic functions:

- Navigation
- Surveillance
- Communications

Whilst it is technologically feasible to adapt space technology to perform these functions, their world-wide use will be governed by several key factors such as economic and cost-effectiveness; institutional arrangements within ICAO and the phasing out of the existing navigation and surveillance infrastructure and its replacement by space-based systems; user acceptance and investment in appropriate avionics, and international (ICAO) agreement on standards.

NAVIGATION

At present, there are 2 candidate systems - NAVSTAR/GPS, a U.S. military system and GLONAS a similar system of the USSR. Both systems rely on a configuration of orbiting multi-satellites to provide complete global coverage (NAVSTAR/GPS requires 24 satellites).

The European Space Agency is presently studying the use of a less costly civil satellite navigation system. This system would also reduce the avionics cost but at present it is in the very early stages of development. Additional studies are being made to determine the cost-effectiveness of combining the Navigation, Surveillance and Communication requirements in one satellite system. Considering the number of options, the need to develop standards, institutional arrangements and other related matters in ICAO, it is not likely that such systems will be in use by civil aviation before the year 2000.

SURVEILLANCE

The use of satellites to automatically interrogate and relay (data link) the position of an aircraft derived from its own on board navigation system down to the ATC system is commonly referred to as "dependent" surveillance and this method was identified by the ARC as the preferred means for civil aviation. Used in conjunction with the ICAO approved airborne collision avoidance system, it offers a safe, operationally viable and cost-effective means of providing ATC with surveillance of air traffic over oceanic and sparsely populated areas. In addition to relaying an aircraft position, the same satellite system can also be used to support other air-ground communications. In the Plan this is one of the options proposed for use in the Low Density Traffic Area.

COMMUNICATIONS

As indicated, the system for surveillance can also support other air-ground data link communications. This would include weather, clearance delivery and other standard messages.

The use of the satellite system to provide air-ground voice communications is costly. It requires ten times as much satellite power as a low data rate (200-400 bit per second) channel and any increase in transmitter power increases the cost of avionics. However, because of developments such as speech encoding and combining the functions of navigation, surveillance and communications, the long term future use of satellites will likely lead to more cost-effective air-ground voice communication.

Satellite communications will continue to be used for the fixed point-to-point service wherever cost-effective. In addition, they will be used to collect data from remote automated weather observing stations. One such system now under development by the Department of Communications called M-SAT will be capable of collecting data from unattended stations.

GROUND TO AIR - THE TERRESTRAL OPTIONS

Given the unlikeliness of widespread use of satellite technology for ground to air systems prior to the year 2000 the plan proposes ground based solutions to surveillance, navigation and communications. The solutions proposed recognize the responsibility of Transport Canada for providing an infrastructure to serve all classes of aviation while minimizing, to the extent practicable, the costs. The solutions therefore represent a balance between direct costs to Transport Canada and to the user and recognize the different needs exhibited by the High and Low Density Traffic Areas. Further, the solutions represent a moderate approach to expansion of systems over the next fifteen years and recognize the probability that space technology may well become an important factor from the year 2000. It should be noted, however, that the Plan caters for the co-existence of space-based and terrestrial systems during the transition period.

NAVIGATION

Options for navigation were considered in the context of the exisitng infrastructure which now provides significant VOR-DME coverage in the High Density Traffic Area but is based primarily on NDB's in the Low Density Traffic Area. Also, the need to make provision for area navigation in both the Low and High Density Traffic Areas was considered to be a high priority in order that more fuel efficient flight profiles for all classes of aviation could be achieved.

In the High Density Traffic Area, given the existing network of VOR-DME's providing airway coverage, the main option considered was to continue expansion of this network for the purpose of expanding the airway system or to lower MEA's, where justifiable, and to provide for area coverage at higher altitudes where suitably equipped aircraft, using area navigation, can be accommodated. It needs to be stressed that the confirmation of the VOR-DME option in this airspace does not preclude the acceptability of other options, where applicable, for suitably equipped aircraft. This, of course, means that self-contained systems such as INS and ground referenced INS/DME systems as well as OMEGA and Loran "C" navigation may be permitted in the High Density Traffic Area under the right conditions. The infrastructure which Transport Canada proposes would therefore continue to be the ICAO standard VOR-DME backed up by the existing low frequency enroute NDB network.

Loran "C" as a primary option was rejected because of the enormous expense which would be required to provide area coverage throughout the High Density Traffic Area (largely duplicating existing VOR-DME coverage) since present coverage is confined to the east and west coasts and the Great Lakes areas.

Omega, while a viable option for the High Density Traffic Area, was not considered the preferred option for this airspace since OMEGA is not provided by Transport Canada and because of the significant existing investment in VOR-DME. Inertial navigation systems are installed at the option of the aircraft and are therefore not a complete option insofar as Transport Canada is concerned. These systems are supported, of course, by the network of DME's which can be used for updating and cross-checking purposes.

In the Low Density Traffic Area the selection of options is not so clear because complete VOR-DME coverage is not presently available and expansion to provide area coverage would be very expensive. It is estimated that over twenty-five installations would be necessary at a cost in the order of $50 million for installations and resulting in significant increases in operating costs. The need for provision of area coverage is primarily related to high level North Atlantic traffic and associated reduction of air traffic control separation in conjunction with minimum fuel routings. Long range area navigation is currently performed primarily using inertial navigation systems (INS) and/or OMEGA navigators. It was considered that by exploiting these two systems, benefits could be provided both to high level and low level flight at a relatively low cost. In the case of INS systems, provision of DME installations would provide for manual checking or automatic updating of INS positions. By locating the DME's at existing NDB locations improved installation cost benefits and enroute navigation to general aviation would be achieved.

LORAN "C" was also rejected as an option for providing area navigation coverage in the Low Density Traffic Area because of the considerable cost involved (estimated to be many times greater than the cost of the OMEGA/VLF, NDB/DME network described below).

In the case of OMEGA, improvements to this system are necessary in certain areas of Canada because of poor pattern geometry as a result of attenuation of the Norway signals over Greenland and unusability of Liberia signals at certain times. This can be achieved by installing one or two complementary VLF stations which could be utilized by most existing OMEGA navigators. Further, developments in the field of Differential OMEGA, can be exploited to improve accuracies of OMEGA to better than ½ NM within the coverage range of NDB's transmitting the differential correction signal. The OMEGA/VLF and Differential OMEGA combination is of benefit to both high and low level traffic. In particular, the Differential OMEGA is expected to provide approach quality signals at airports within the coverage of the selected NDB without requiring an approach facility at the airport. The proposed option therefore incorporates 16 DME's at selected NDB's, one or two VLF stations and approximately 26 Diffferential OMEGA installations. The associated costs of the proposed network would be in the order of $7 million. Although airborne OMEGA navigation installations may be considered expensive at this time the expectation is that costs will decrease as demand increases and that the benefits from utilizing OMEGA in the Low Density Traffic Area will allow operators to justify the costs. The concept of providing lower quality VOR installations for the Low Density Traffic Area is considered to be an undesireable option because ICAO requires VOR's to meet certain standards and because the costs would undoubtedly be significantly higher than the proposed option.

SURVEILLANCE

In like manner to communications, there is little scope for exploitation of any new options in the realm of high capacity air traffic surveillance. The high density traffic area demands the continued use of primary and secondary radar with their high capacity ability, enabling the use by ATC of lower separation minima. Improved secondary radars, replacing the older installations, are a part of the approved RAMP program and future enhancements provide for inclusion of SSR Mode S capability. SSR Mode S improves surveillance accuracy to support automation enhancements, provides interference-free aircraft identification and altitude data and eliminates code garbling occuring today in high density areas. It will also provide two way ground to air data link, enhance safety by providing back-up to voice, weather data direct to the cockpit and increase productivity in ATC automation. SSR Mode S is fully supported by ICAO and the FAA's SSR Mode S program has been approved for implementation.

In the Low Density Traffic Area, where installation of SSR Mode S would be prohibitively costly (if satellite data link communications are not used) "dependent" surveillance using HF data-link position reporting is the only option now open and is proposed in the Plan. The lower capacity ability of this means of surveillance is not a constraint due its use in areas of lower traffic density.

COMMUNICATIONS

There is little scope for exploitation of options in the communications field when considering ground based systems. The primary communication frequencies will be in the VHF band for direct ground to air contacts. Since VHF frequencies require line of sight between the ground station and the aircraft certain geographical areas are difficult or even impossible to cover. For this reason HF communications will continue to be available for long range applications and for gap filling purposes in the Low Density Traffic Area.

The two options available using these media are the transmission of voice or data. The present system is totally based on voice transmissions. The gradual shifting of emphasis from voice to data transmission will permit improvements in communications efficiencies, reduce communication errors and increase the reliability of communications particularly at HF frequencies. The extended use of data transfer from suitably equipped aircraft will permit positive ATC surveillance in areas beyond of radar coverage and thus improve service through reduced aircraft separation criteria and minimum fuel routings/profiles.

CONCLUSION

This plan identifies the capital investment required to modernize and consolidate the Canadian Airspace System, the major systems engineering development and the facilities and equipment acquisition programs to accomplish it, the strategy to carry it out and the major decisions facing the Administration to ensure its success.

The plan will:

- Permit evolution to an integrated system.
- Ensure no degradation or loss of existing services.
- Improve services where deficiencies exist.
- Accommodate foreseeable increases in traffic levels and a wide range of demands for services.
- Minimize future staffing levels and operations and maintenance costs.

Implementing the plan will be expensive and will proceed more slowly than many would wish. However, the sheer magnitude of the task, along with the technological innovations required to avoid early obsolescence, and the need to constrain expenditures make the plan practical.

The plan, in order to be executed efficiently, will be frequently updated in its detail, amendments being made as results of the systems engineering development efforts become apparent. There will be continuous Executive and Legislative surveillance but it is also necessary to make a funding commitment now in order to take full advantage of the integrated systems concept with its attendant evolutionary approach to implementation.

CHAPTER 2

DEMAND ON THE SYSTEM

CHAPTER 2 DEMAND ON THE SYSTEM

INTRODUCTION

This chapter provides a brief look at the influencing factors on future demand; reviews the prospects for air transportation, including the Fleet outlook; indicates the air traffic demand for airports and airspace; reviews the expected utilization of airborne equipment; and concludes with a short discourse on meeting the demand in terms of the need for system improvement and the proposed solution.

SOCIO-ECONOMIC AND ENERGY INFLUENCES ON FUTURE DEMAND

In mid-1982 the Strategic Planning Group of Transport Canada predicted moderate economic growth with continued inflationary trends over the next ten years. A growth rate in the Gross National Product of 4.3% between 1983 and 1985 is expected, with inflation over the period 1982 to 1990 being 5 or 6%. The economic downturn in late 1981 and 1982 underscores the uncertainty in all such forecasts, and major short term changes can be seen over a period of six months or less, making long-term prediction difficult.

Rising costs, budget deficits, and competition from energy-related sources are all expected to reinforce the trend to fiscal restraint on the part of the Federal Government. The Air Administration's ability to respond to increasing demand with appropriate new facilities will continue to be constrained. Air carriers may find it difficult to finance the fleet purchases required to meet even a modest growth in demand.

The dominant socio-economic force arising from this situation will be one toward economy of operation of the national civil air transportation system. For the airspace services, economy, productivity and capacity, without degradation of safety, offered by the proposals in the Canadian Airspace Systems Plan should be seen as a positive solution to the problem of resource constraints dictated by the socio-economic influences.

Recent oil price agreements cover the period to 1986, thereby providing some certainty for short and medium term planning. If the self-sufficiency goals of the National Energy Program are successful, stability can be expected in the longer term as well, although regional variations may continue to be a problem. The only near certainty is that fuel prices will continue to increase over time.

The dominant force arising from the energy situation will be toward efficiency, energy savings, and best use of energy resources. These pressures may affect all aspects of the air transportation system. Energy is therefore an area that will require continual monitoring as a regular part of the planning process.

FUTURE AIR TRANSPORTATION DEMAND

Aggregate demand indicators for the "Top 25" airports in Canada indicate a modest growth rate from now until 1991. Aggregate forecasts to the year 2000 are not yet available. The current traffic forecasts indicate a somewhat lower economic growth in Canada than had been forecast in 1981.

The overall average growth in Mainline Unit Toll Passengers enplaned and deplaned at the "Top 25" airports is expected to be about 3.0% per annum between 1981 and 1991. Cargo tonnage, originally predicted to grow at a rate in the 4-6% range, has been reexamined in light of economic conditions and energy price changes and now is predicted at about 3% for the decade. Average growth in the total itinerant air carrier and general aviation aircraft movements is expected to be around 2.4% per year from 1981 to 1991.

Regional variations are expected, with greater growth in western Canada than in Central or Atlantic Canada. Individual exceptions or unusual growth in specific areas may result from industrial activity associated with new energy "mega-projects".

AIR TRAFFIC DEMAND - THE FLEET OUTLOOK

The overall fleet of registered aircraft in Canada is presently forecast to grow, from some 24,700 in 1982 to 31,600 in 1991.

The replacement value of the existing unit toll fleet is around 3.4 billion. The total value of the aircraft fleet required in 1996 will be in excess of $7 billion. Accounting for retirement of a large portion of the existing fleet, the financing needed to purchase new aircraft may be in the order of $4 billion by 1991 and may reach $5 billion by 1996 measured in constant dollars. Ground facilities and other requirements will increase this even further.

Selection of aircraft will be a key problem on which both financing and ultimate airline profits may depend. The problems of excess capacity for major carriers will exist for at least the short term (5 years), and since many new aircraft are being leased through third parties rather than purchased outright by the airlines, lessors will be concerned about the durability of demand for the product they are purchasing. Selection of aircraft matched to route demands will be critical. Viability of carriers will also depend on the degree of regulation and competition. Deregulation in the United States has led to an increase in the numbers of flights on certain routes, and therefore in viability in satisfying operating costs.

Contrary to earlier predictions that the aircraft industry would be producing even larger aircraft during the 1980s and 1990s, there is now a trend emerging toward lower sales of the high-capacity wide-body jet aircraft. Growth is expected in sales of 30-70 passenger aircraft such as the de Havilland DHC-7.

In order to increase efficiency, airlines are apparently looking to acquiring aircraft that are more specifically suited to their routes and passenger volumes, to allow the highest possible load factors. They want to acquire aircraft that are designed strictly for efficiency. Consequently, the manufacturers are looking to more fuel efficient engines, use of special composite materials, new designs for airfoils and control surfaces, and extensive use of advanced digital avionics (computerized instrumentation) to reduce fuel consumption per available seat-kilometre possibly by 40%.

The outlook for general aviation is similar. More emphasis on fuel efficiency will affect aircraft design. As inflation in aircraft costs is increasing faster than disposable personal income, there has been some dampening of demand for small aircraft. There is not expected to be a return to the earlier growth rates of small aircraft in the forseeable future. Increased use of general aviation aircraft for business use appears to be leading to greater sophistication of instrumentation. This segment may dictate the long term trends and affect the need for ground facilities the most.

AIRPORT DEMAND

There are presently 1165 airports (licenced aerodromes) in Canada, of which Transport Canada owns 172. There are also 44 aerodromes owned by the Department of National Defence. The Federal Government operates 116 of its airports, with the remaining 56 operated by other levels of government or private agencies for the Federal Government.

Analyses carried out as a part of the development of the National Airports Plan have concluded that the air traffic demand at a few airports in Canada will exceed the runway capacity at varying times up to the year 2000. The capacity-deficient airports are those situated in the higher population densities and there is increasing resistance to the adverse environmental impact of airport growth in these areas. Because of this, and the expensive and difficult task of land acquisition for the enlargement of facilities or construction of new airports, expansion in these areas will be limited.

There are no long range plans for construction of any new international airports. However, application of good design development principles, an improvement in the Air Traffic Control infrastructure, with the possibility of a reduction in aircraft separation minima, improvements in landing aids, redistribution of traffic amongst the airports within a zone will assist in providing any required increase in capacity. Any remaining problem areas might eventually be forced into accepting quotas and flow control restrictions and could result in schedule changes for alleviating peak hour congestion. In the long term, the Systems Plan includes provision of a flow management system, the specific planning for which would commence only when the needs are clearly identified. Runway capacity is not perceived as a major problem in the same manner as, for example, in the United States, but the need for contingency must be conceded. Also, it must be recognized that any regulation of demand involves government policy, CTC, bilaterals, the Aeronautics Act and Regulations and orders pursuant.

AIRSPACE DEMAND

The geographical distribution of the major air traffic flows within Canadian airspace is directly related to the location of the main airports, situated in the proximity of the larger urban populations. These flows consist mainly of domestic traffic departing from one Canadian airport and arriving at another Canadian airport. Of the total itinerant movements at the 60 controlled airports in Canada, about 90 percent are domestic.

The remainder of the itinerant traffic of the 60 airports originates from or is destined for airports outside Canada. These flows are Transborder, Pacific, North Atlantic and Polar.

In addition to the aforementioned traffic of Canadian airport origin/destination, there is the traffic which overflies Canada between Alaska and mainland USA, the North Atlantic and the USA and Polar regions and the USA.

The main concentration of traffic is roughly along two axes, Vancouver to Toronto and Newfoundland to Toronto. Short haul domestic flights tend to utilise the same route throughout the year, remaining close to the direct track between airports. The medium and long haul flights will vary their flight plan route, utilizing airways which deviate from the main direct axis between origin and destination according to the appropriate minimum time track (MTT). The MTT between any two airports varies throughout the year, being dependent upon the weather patterns and the performance characteristics of each particular flight profile. Taking account of these factors and of the variations in climb and descent performance of aircraft within the terminal airspaces there is a volume of airspace across the Southern part of Canada within which the majority of domestic flights flow. This high density traffic demand area is related to the two aforementioned axes but expands at the Atlantic and Pacific coasts, accommodating the additional flows of traffic in these areas. The remaining portion of Canadian Domestic Airspace is referred to as the Low Density Traffic Area. Both areas are depicted in Figure 2.1. Most IFR traffic in the high density area operates above 12,500 feet.

Finally, Canada has responsibility, through ICAO, for the provision of Air Traffic Services within the western portion of the North Atlantic Airspace. This area of air traffic demand is the Gander Oceanic Control Area, shown in Figure 2.2, containing mainly east-west flows of traffic, whose tracks vary daily according to the weather patterns between Europe and North America. About two-thirds of this traffic flows to and from airports located in the United States, with a considerable portion of their flight profiles being within Canadian airspace. The remainder of the North Atlantic traffic originates from or is destined for Canadian airports. The majority of North Atlantic traffic operates above 27,000 feet.

All the aforementioned areas contain significant flows of traffic, the nature of which requires provision of an air traffic control system. In both the high and the low density areas, greater emphasis must be placed on strategic air-traffic management, by exploitation of automation for the provision of conflict-free, hazardous weather avoiding, fuel-efficient flight clearances. This will be achieved by the development of a fully integrated system of navigation, communications and surveillance facilities, supporting a computer-based air traffic control system.

ATC surveillance in the High Density Traffic Area is achieved by use of the high capacity SSR System. In the low Density Traffic Area (and Gander Oceanic) surveillance is achieved by use of the lower capacity position reporting (dependent) system. In the future, as the system needs to change from voice communications to data-link, SSR Mode S will be used in the radar enviroment and HF or Satellite will be used in the non-radar environment.

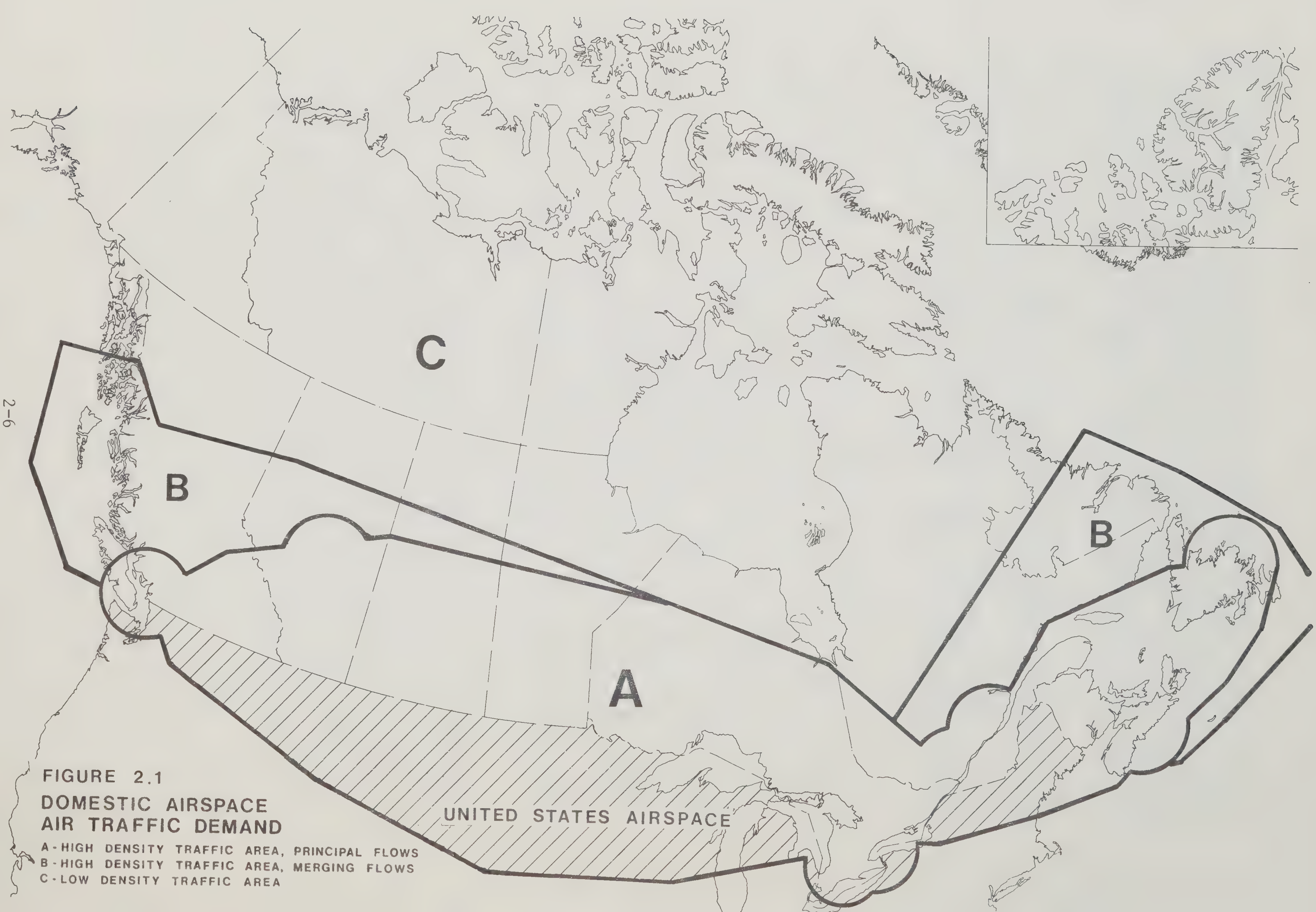


FIGURE 2.1

DOMESTIC AIRSPACE
AIR TRAFFIC DEMAND

A - HIGH DENSITY TRAFFIC AREA, PRINCIPAL FLOWS
B - HIGH DENSITY TRAFFIC AREA, MERGING FLOWS
C - LOW DENSITY TRAFFIC AREA

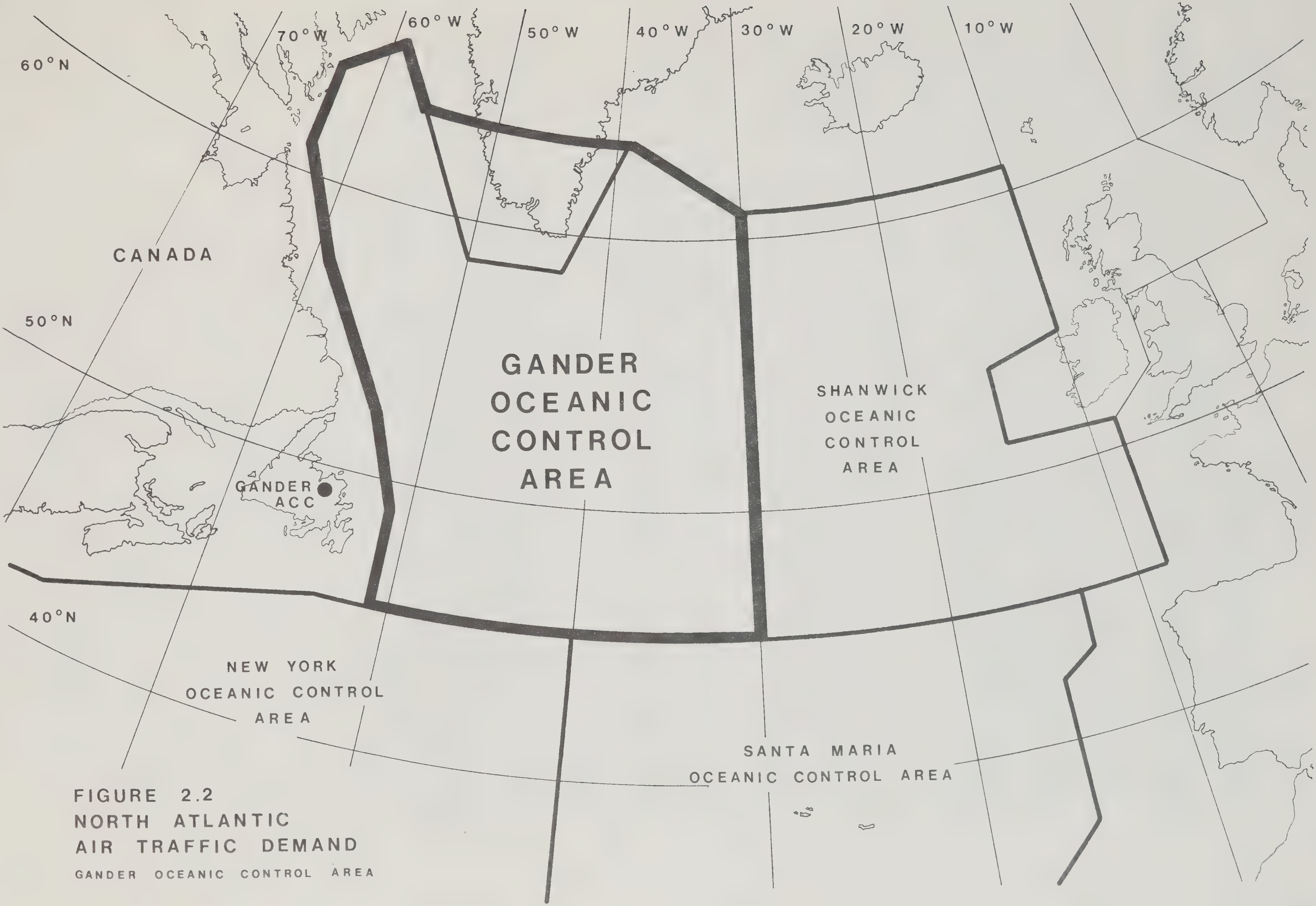


FIGURE 2.2
NORTH ATLANTIC
AIR TRAFFIC DEMAND
GANDER OCEANIC CONTROL AREA

AIRBORNE EQUIPMENT UTILIZATION

Airborne equipment during the next two decades will be utilized within four categories:

- Navigation Systems
- Air/Ground Communications Systems
- Aircraft Separation Systems
- Approach and Landing Systems

Projected utilization of equipment within Canadian airspace during the next two decades is illustrated in Table 2.1.

NAVIGATION

Use of VOR/DME, a co-located very high frequency omni-directional range station (VOR) and distance measuring equipment (DME); area navigation systems, either the self contained Inertial Navigation System (INS), or those utilizing VOR/DME, LORAN C or Omega; and to a lesser extent, non-directional beacons (NDB) are expected to continue at least until the end of the century. More advanced systems of mapping and 4-dimensional area navigation should become commonplace by the year 2000. Satellite navigation is not forecast to be in widespread use.

The flight management system, an integrated system for flight guidance and control, will be standard equipment in the new generation of transport category aircraft. The system design provides for three-dimensional navigation throughout the entire flight profile and growth capability to 4D navigation.

COMMUNICATION

Use of Very High Frequency (VHF) communications is anticipated to remain predominant throughout the period with the use of Ultra High Frequency (UHF) decreasing. High frequency (HF) communications will continue to be used in the areas of non-VHF coverage, such as the north and the Gander Oceanic Control Area and will eventually provide the means of ground/air data link in those areas. By the year 2000 there will be widespread use of data link systems utilizing SSR Mode S or HF. Although not expected to be commonplace, aeronautical satellite communications will be on the increase.

SEPARATION

The present Secondary Surveillance Radar (SSR) transponders will be replaced by SSR Mode S transponders. A Traffic Alert and Collision Avoidance System (TCAS) will provide an independent airborne collision avoidance capability.

APPROACH AND LANDING SYSTEMS

The Microwave Landing System (MLS) will replace the Instrument Landing System (ILS) as the standard aid for precision approaches. Area navigation is expected to be in widespread use. The use of electronic approach plates is also expected to increase. Category III approach capability will exist in aircraft flying in Canadian airspace although only a few airports are expected to require Category III ground installations.

TABLE 2.1 AIRBORNE EQUIPMENT UTILIZATION

SYSTEMS	1981	1985	1990	2000
NAVIGATION				
VOR/DME	W	W	W	W
SATELLITE NAV	-	-	L	L
DME	W	W	W	W
INS	L	I	W	W
LORAN C	L	L	L	L
OMEGA/VLF	L	I	W	W
DOPPLER NAV	L	D	D	D
NDB	W	W	W	W
RNAV	L	I	W	W
4D RNAV	-	L	I	W
MAPPING	L	I	W	W
FMS	L	I	W	W
COMMUNICATION & DATA LINK				
VHF COM	W	W	W	W
UHF COM	L	L	L	L
HF COM	W	W	W	D
MODE S TRANSPONDER	-	-	L	W
VHF DATA LINK	L	L	L	L
SATELLITE	-	-	L	I
VHF Wx DATA BROADCAST (VOR)	-	L	W	W
HF DATA LINK	-	-	L	W
AIRCRAFT SEPARATION				
TCAS	-	-	L	W
COCKPIT DISPLAY TRAFFIC INFORMATION	-	-	L	I
SSR TRANSPONDER	W	W	W	D
SSR MODE S TRANSPONDER	-	-	L	W
APPROACH & LANDING SYSTEMS				
MLS	-	L	I	W
ILS	W	W	W	D
ADF	W	W	W	W
VOR	W	W	W	W
RNAV	L	L	I	W
HUD	-	L	I	W
ELEC. APPR. PLATE	-	-	L	I
CAT. III	-	-	-	L

LEGEND

L = LIMITED USE
I = INCREASING USE
W = WIDESPREAD USE
D = DECREASING USE

MEETING THE DEMAND

The conclusion to be drawn from the air transportation outlook is that there is likely to be at least a modest growth in air traffic demand. It is therefore a requirement to provide adequate facilities and equipment to meet these demands. To do this it is necessary to look at how well the current demands are being met. Today's Airspace System utilizes a combination of equipment, techniques, procedures and skills that have evolved over a number of years. This evolution has produced a mixture of equipment of many ages, technologies and types. It is as safe and efficient as any system in the world, but it is very expensive to operate and maintain, has limited expansion capability and it is difficult to adapt to changing requirements. There is need for improvement in a number of areas as shown in the following examples.

Weather Information

The provision of weather information is a vital service concerning the safety of flight. It is currently highly labour orientated, providing only a "one-on-one" service. Demand has outstripped capacity and automation must be exploited in order to meet the demand for timely and accurate weather information.

Data Processing Capacity

The current capacity of the automated air traffic control system is limited and must be increased by selecting new equipment.

Aging Electronic Equipment

Much of the electronic equipment in use is of the vacuum tube type, with high operation and maintenance costs and is in need of replacement by sold state equipment.

Route-Structure Limitations and Control Methods

Today's network of ATS routes is based on the need to provide a navigational structure amenable to control by a ground organization.

It is inflexible and does not meet the increasing requirement for fuel-efficient flight profiles. Additionally, frequent tactical interventions are needed to maintain separation. A more strategic system of control, with fewer demands for intervention, permitting direct flight routings is therefore needed.

Other System Inefficiencies

Inefficiency results from a variety of weaknesses in the system.

These include:

- variations in controller consoles and display equipment in en-route and terminal facilities.
- a multiplicity of leased communications lines.
- poor data transfer methods.
- practically no systems integration.
- no interfacility data transfer.
- variations in types of computer and software languages.
- highly labour intensive operations involving extensive supply, training and technical support.

THE SOLUTION

In order to overcome the aforementioned deficiencies, the system must be modernized and a fresh look must be taken at the manner in which development of equipment and facilities is carried out.

In recent years there has generally been a lag between the time that facilities were needed and the time that they become operationally usable, making it difficult to satisfy adequately the demands for various services.

With the continuing advance in technology pertaining to the many sub-components of the total system it has become increasingly necessary to satisfy demand, not in a piecemeal fashion, but by a total systems engineering approach, permitting an evolutionary development of equipment and facilities, flexible enough to meet the foreseeable range of changing demands as and when they are needed.

The systems on the ground must not only be integrated within their own technical framework but must also integrate with the airborne systems, the technological capability of which is advancing faster than that of the ground systems capability. This total integration concept will ensure that whatever effect demands on one system have on the other systems they will be fully taken into account in deciding the optimum development options.

CHAPTER 3

AIR TRAFFIC CONTROL
EN-ROUTE AND TERMINAL

AIR TRAFFIC CONTROL - ENROUTE AND TERMINAL

Canada's Air Traffic Control (ATC) organization is functionally responsible for providing control and advisory services in the airspace overlying Canada and in international airspace for a major portion of the North Atlantic. Covering an area of about 5.8 million square miles, Canada's ATC responsibilities are second only to that of the United States.

Operated from Area Control Centers (ACC's), Terminal Control Units (TCU's) and Control Towers (TWR's) the ATC System forms an integral part of Canada's National Airspace System. From TWR's controllers provide ATC services on the airport and in the airspace in its immediate vicinity (Airport Control Zones). ATC services provided from TCU's apply within Terminal Control Areas which are larger volumes of airspace and include one or more airports. ACC's are responsible for providing ATC services in an entire Flight Information Region (FIR), of which Canada has 7 domestic and 1 oceanic FIR.

ATC services in Canada are provided in various types of airspace classified in accordance with specific flight rules and procedures; details are contained in the Designated Airspace Handbook (TP 1820). However, for the purpose of developing the ATC systems plan, traffic density-related areas, described in Chapter 2 (Figures 2.5 and 2.6), reflect the distribution of demand for air traffic services.

All air traffic operations in Canada are carried out in accordance with one of two basic rules:

- Instrument Flight Rules (IFR).

- Visual Flight Rules (VFR).

For flights operating under IFR within controlled airspace, the responsibility for ensuring safe separation from all other IFR flights rests with ATC and the separation minima used are commensurate with the surveillance and navigation capabilities pertaining to the particular airspace. For flights operating under VFR, pilots are responsible for their own separation and operate on a "see-and-be-seen" basis.

The ATC system, which is a composite of interdependent subsystems, is used in conjunction with rules and procedures to control air traffic. It is a centralized ground-based management system but the responsibility for the navigation of aircraft remains with the pilot. Most aircraft are navigated by reference to a system of ground-based radio navigation aids, strategically distributed to delineate the airway/air route structure.

Functionally, the important ATC subsystems are categorized as:

- Flight Data Processing System -- the system or means by which flight plans (aircraft intentions) are acquired, processed and displayed in order to provide controllers with a strategic overview of the projected air traffic situation.

- Surveillance or Radar Data Processing System -- the system by which the actual or real time (continuously updated and generally sensor-derived) air traffic situation is displayed. Within the high density traffic area, where reliance on tactical control is necessary for safe and efficient air traffic operations, surveillance is, and will be in the foreseeable future, effected through radar data processing systems.

- Communications (air-ground and ground-ground) Systems -- the system or means by which voice and data communications are achieved between controllers and pilots and with flight service specialists.

- Aeronautical Information Systems -- the system or means by which information on environmental conditions such as wind direction and speed, weather, visibility, temperature, and other aviation related conditions such as serviceability of navigation aids and runway status are acquired and displayed to assist in the provision of advisory services to users.

The ATC service provided by TWR's, of which Transport Canada operates 60, is primarily based on visual detection and control. At busier airports, radar data displays are used to monitor air traffic operating in the vicinity of the airport. At Toronto, Vancouver and Mirabel, Airport Surface Detection Equipment (ASDE) enables controllers, during conditions of reduced visibility, to monitor the position of aircraft and vehicles on the manoeuvring area of the airport. At some TWRs, Very High Frequency Direction Finder (VHF-DF) equipment enables controllers to provide pilots with direction information.

There are 15 TCU's in Canada's ATC system, 7 of which are colocated (integrated) with the ACC's at Gander, Moncton, Montreal, Toronto, Winnipeg, Edmonton and Vancouver. The other TCU's are situated at Halifax, Quebec City, Ottawa, North Bay, Thunder Bay, Regina, Saskatoon and Calgary. A TCU is primarily responsible for providing ATC services within Terminal Control Areas (TCA's) to all arriving and departing IFR flights. TCA's vary in size depending on the volume and complexity of air traffic operations. Within this airspace control is principally effected by the use of radar surveillance. At the busier locations, such as at Toronto, Montreal and Vancouver, the TCU's also provide advisory services to VFR flights operating within the Terminal Radar Service Area. TCU's are typically organized into a number of workstations; each workstation being operated by one controller covers various functions such as arrival, departure and coordination.

At present, different types of systems and equipment are provided at TCU's. Those TCU's located within the ACC's are equipped with recently installed computer-based systems. These systems are the same as those used in the ACC's and are described later. At the stand-alone TCU's no computer based systems are used. At these facilities the equipment used to present the air traffic situation consists of:

- Primary Surveillance Radar (PSR) and a colocated Secondary Surveillance Radar (SSR) -- the sensors which provide the radar surveillance capability.

- Radar data displays -- scan-converted TV displays and analog plan position indicators.

- Flight data strips -- manually produced, containing information on the identity of the flight, its intended route and altitude, and other related information.

- Communications (air-ground and ground-ground) -- consists of radio telephony and telephone links. Teletype circuits link TCU's with the aeronautical fixed telecommunications network (linking all ATS facilities).

- Operational information -- including weather data, NOTAMS, etc., generally handwritten and displayed on slips of paper, or boards.

ACC's are responsible for providing control, advisory and alerting services within its FIR. The ACC at Gander has additional responsibility for its Oceanic FIR. The main function of an ACC is to monitor and control an aircraft's route and altitude while it is enroute between airports. An ACC's geographic area is usually divided into several sectors with a team of controllers responsible for each sector. The type of surveillance system provided at the control sector (workstation) is based on factors such as air traffic density, safety and operating efficiency. In the high density traffic area, radar systems are the princpal means of providing surveillance and permit the use of lower separation minima (spacing between aircraft). In the low density traffic area or oceanic area where the use of radar systems is not possible nor economically justified, surveillance of air traffic is achieved by reference to aircraft (pilot) position reports. In this airspace considerably greater spacing between aircraft has to be used to ensure a safe operation.

At the ACC's with colocated TCU's, equipment used to present the air traffic situation consists of:

- PSR and SSR systems -- the sensors which provide the radar surveillance capability.

- Radar Data Processing System (RDPS) -- the system which processes and displays the radar data. At present the Joint Enroute Terminal System (JETS) provides this capability at all ACC's and colocated TCU's.

- Flight Data Processing System (FDPS) -- at present the system produces only flight data strips.

- Operational Information Display System (OIDS) -- the system which provides controllers with real-time data such as wind direction and speed, temperature, barometric pressure and visibility for major airports. It also provides weather sequences, NOTAMs and other related aeronautical data, for retrieval by the controller.

- Integrated Communications Control System (ICCS) -- the versatile computer based system for controlling (switching) intra- and inter-facility voice communications.

- Voice communications -- the ground-to-air VHF radio telephony, and ground-to-ground telephone (voice) links.

- Automated Data Interchange System (ADIS) -- the domestic portion of the Aeronautical Fixed Telecommunications Network (AFTN) which enables transfer of data between ATS facilities.

The equipment at Gander ACC, to support domestic ATC requirements, is the same as at the other ACC's. However, for oceanic ATC, there is a more advanced flight data processing system, the Gander Automated Air Traffic System (GAATS). Features of this system include:

- Prediction of air traffic conflictions (and warning messages).
- Printing of flight strips.
- Automated data interchange with the oceanic centre in Prestwick, Scotland.
- Statistical data gathering on oceanic operations.
- Automated flight plan transfer to the Joint Enroute Terminal System.
- Automated transfer of data on the Organized Track System, (OTS) to the Aeronautical Fixed Telecommunications Network.
- A weather model which enables the calculation of flight times and minimum time tracks.

Equipment and systems currently being used for ATC vary from modern to that acquired some 25 years ago. The older equipment, particularly the radar systems and displays, are no longer able to meet operational requirements. In addition to problems of reliability and availability the systems are also very expensive and difficult to maintain and adversely limit the extent to which productivity improvements can be made. Some equipment-related problems are:

- The lack of controller workstation equipment standardization (except in the ACC's).

- Virtually no systems integration, consequently, input of ATC data has to be duplicated making the system unnecessarily labour-intensive.

- Inadequate on-site simulation capability for controller training and proficiency evaluation.

- Obsolete computers with limited capacity.

- The absence of a real time on-line Flight Data Processing System for the automated acquisition, processing and transfer of air traffic information.

These equipment-related limitations as well as the systems' inability to handle data from the new Radar Modernization Project (RAMP) radars will need to be resolved in order to realize the extensive benefits and reduction in operating costs, that automation offers. Also, most functions, such as conflict checking, issuing of ATC clearances and advisories, and transfer of control of an aircraft from one controller to another still involve manual actions, adding to the workload.

Systems for controller training are also in need of urgent improvement. Recent studies have shown that the cost per successful trainee is inordinately high. More effective training systems, capable of accurately simulating the ATC environment, have been identified as a means of reducing controller training costs. Existing training systems at the Regional schools are not adequate.

The study of ATC problems such as operating procedures and human factors, is carried out at the ATS Research and Experimentation Centre. The use of this facility has enabled the safe introduction of proven cost effective operating practices. To meet the demands of the future considerable upgrading of the facility will be required.

THE NEW APPROACH

The future ATC system will gradually evolve from being dependent on tactical control, which is inherently labour-intensive, to a more strategically managed and efficient control system. The future ATC system will still be sensitive to airport acceptance capacities, but with the availability of real time flight demand data provided by the interlinked and regionally centralized Flight Data Processing Systems a Flow Management System will provide close to "no delay" operations.

The enhanced surveillance (radar) coverage and air-ground data transfer through Mode S, together with improved controller workstations and upgraded interfacility communications, will enable air traffic operating in the high density traffic area to fly the most fuel-efficient flight profiles. In the low density traffic area and oceanic area, air-ground data transfer via HF or satellite will also provide for more efficient aircraft operation. Based on this real time acquisition and processing of aircraft data, the ATC system will be upgraded to provide the controller with computer-calculated conflict prediction and conflict resolution information.

The objectives of modernizing the ATC system are to maintain a very high level of safety, impose minimum constraints consistent with efficient use of the system, increase controller productivity and minimize operating costs. This involves extended use of automation and the replacement of obsolete equipment.

Development of an automated real time Flight Data Processing System (FDPS), interlinked with other systems and facilities, will be the first step in establishing the future integrated ATC system. Initially, emphasis will be placed on improving the data distribution capability of the Flight Data Processing Systems. To accomplish this, features such as meteorological data for calculating fix times, sector printers, and automatic intersystems and interfacility data transfer will be implemented. Eventually, electronic data displays will replace paper flight strips and new functions will be added to provide aircraft with computer generated conflict free, fuel-efficient flight profiles. Data from the Flight Data Processing System will be passed to the central Flow Management System. The purpose of the Flow Management System is to ensure that effective utilization of airspace and airport capacity are maintained with minimum delay to users. Functions to assist the controller, such as conflict prediction and conflict resolution alternatives, will be included in the Flight Data Processing System.

To meet internationally identified oceanic ATC requirements, several enhancements will be made to the Gander Automated Air Traffic System (GAATS). A key enhancement to GAATS is the early implementation of air traffic situation displays depicting the air-ground data link derived real time position of aircraft. Computer generated conflict resolution and conflict free, fuel efficient profiles within or independent of the Organized Track Structure will be incorporated.

Eventually, the Flight Data Processing System and the Gander Automated Air Traffic System, in terms of real time data processing and capability, will be functionally identical and will be based an common hardware and software.

Through several evolutionary steps the present Joint Enroute/Terminal System (JETS) will be upgraded to become the future Radar Data Processing System (RDPS). The RDPS will continue to use the distributed processing configuration of the existing Joint Enroute Terminal System and will be designed to provide 100% availability and reliability. Several new functions will be added to the Radar Data Processing System to provide a comprehensive display of radar derived data including:

- Display of hazardous weather.
- Multi-tracked or mosaiced radar data.
- Conflict alerting.
- Minimum safe altitude warning.
- Mode S data link and information display.
- Radar data recording and play-back.
- Statistics recording and analyses.

The SSR Mode S is a combined secondary surveillance radar and air-ground data link system capable of providing improved aircraft surveillance data and communications necessary to support ATC automation in the increased traffic density environments expected in the future. It will be compatible with current SSR transponders (avionics) and thus implementable at low user cost over an extended transition period.

The new Communications Control System, with its functional capability similar to that of the Integrated Communications Control System (currently installed at all ACC's) will be implemented at all ATS facilities.

In addition to reducing operating costs, the new system will provide more efficient and flexible intrafacility communications. Existing communications equipment in TWR's, FSS's and stand-alone TCU's will be replaced with the new Communications Control Systems. In the early 90's the existing Integrated Communications Control Systems, installed in the ACC's will also have to be replaced since these systems will become costly to maintain. Larger and more versatile versions of the Communications Control System will be implemented. Local area network techniques and integrated voice and data will be included in the new systems. Reliability and availability of almost 100% will be designed-in requirements of the system.

The Operational Information Display System (OIDS) will be enhanced and expanded to serve as the regional (centralized) data base for aeronautical information and will be accessible by all ATS facilities and workstations. While these regional Aeronautical Information Processing Systems will be capable of meeting most needs, there will continue to be a requirement for local (at the airport) real time data such as instantaneous reading of wind speed and direction, runway visual range and the status of approach and landing aids. These requirements will be met through scaled down versions of today's Operational Information Display System. Other non real time critical aeronautical information will be centralized in the regional system. Aircraft equipped with air-ground data link will also be able to access data directly from the regional Aeronautical Information Processing System.

Systems such as the Flight Data Processing System, the Aviation Weather Processing System, and the Aeronautical Information Processing System will be situated at each Area Control Center and will be developed to serve an entire Flight Information Region. These regional systems will be directly accessible by all ATS facilities and workstations. The systems will be interlinked and will also be accessible by users (airlines and aircraft operators).

As a part in realizing the extensive benefits of automation and total systems integration, a versatile controller workstation (sector suite) built around air traffic situation displays will be developed. The main display (geographical format), similar to present-day radar displays, will depict annotated (tagged) real time data derived from multi-radar sensors or aircraft positional data obtained via air-ground data link. At some workstations, data derived from both sources will be integrated and displayed. Complementing the geographical display will be a tabular display of flight data. This display is the long term replacement of data now displayed on paper flight strips. The displays will be interchangeable and capable of automatic back-up in the event of failure. Additional supplementary displays for ATC planning and probing, and for displaying aviation related information will complete the sector suite. Considerable human engineering will be required in developing and introducing these highly automated sector suites.

To reduce the chances of total system failure, each sector suite will be capable of operating autonomously. Using distributed processing (minicomputers/microprocessors at each sector suite) the capability will be provided for maintaining limited data bases and for supporting several ATC functions. To the maximum extent practicable workstations in TWR's and FSS's will have equipment common to that of enroute and terminal facilities.

The deployment of ground-independent airborne separation assurance systems such as the TCAS (Traffic Alert and Collision Avoidance Systems) will introduce a further level of overall system redundancy. The TCAS is a significant feature of the FAA's National Airspace System Plan and the timing of its use in Canadian airspace will depend on experience gained in the United States and in its acceptance by users.

In summary, CATA's modernization plans are designed to replace the current ATC systems, and to develop new systems in conformance with meeting the future needs for improved safety, greater capacity and reliability. Against a projected doubling in traffic growth by the year 2000, modernization of the ATC system, principally through the comprehensive use of automation, will ensure virtually no growth in the number of air traffic controllers compared with the present strength but will result in a significant increase in productivity.

Admittedly, the cost of modernizing the ATC system will be great, but the impact of not doing so will result in substantialy higher operating costs, critical failures of system components (which would adversely impact safety), reduced controller productivity, and costly delays to users.

HOW THE SYSTEM WILL EVOLVE

Near Term (To 1985)

During this period, activity will be concentrated on modifying existing ATC computer-based systems to increase their capability and capacity. In the case of JETS (the Radar Data Processing System) the situation is particularly urgent. In addition, to reduce and eventually eliminate the need for duplicated manual data entry, labour saving enhancements such as intersystem links will be incorporated. Although improvements to systems and equipment in ACC's and colocated TCU's will be carried out, no similar improvements are planned, during this period, on existing equipment in TWR's and standalone TCU's.

As a stop gap measure, to overcome critical problems in radar data processing caused by the present limited capacity of the JETS, memory expansion of the system's central computer complex will be implemented. In parallel, replacement of these computers with new hardware and memory expansion of the JETS display processors will be started. The design specification for the new hardware will provide for additional computing capacity to process surveillance and weather data from the new RAMP radar systems. The system will be easily expansible to accommodate future functional enhancements such as conflict prediction and resolution. Upgrading existing software to a high order language will be started in 1983/84. An operational improvement, radar mosaicing, will be added to enable the display of the best positional data of aircraft derived from two or more radar systems.

The Flight Data Processing System will be upgraded to provide flight strip printers at controllers workstations. To eliminate the dual entry of flight plan data and to provide operating efficiencies, the flight and radar data processing systems will be interlinked. By the end of this period, all ACC's will have a nucleus Flight Data Processing System capable of modular expansion to accommodate growth and functional enhancements to support real time data acquisition, processing and distribution requirements.

The Gander Automated Air Traffic System (GAATS), which is the oceanic flight data processing system, will have more efficient software incorporated to increase its computing capacity. This more efficient high order language, and other real time flight data processing functions, will serve as the model for the upgrading the domestic flight data processing systems. Operational improvements to GAATS will include alphanumeric displays for the automatic presentation of aircraft position reports to controller workstations, and a link to the aeronautical fixed telecommunictions network to enable the automatic reception and transmission of flight plan data.

The Operational Information Display System (OIDS), which provides aeronautical information to controller workstations in the ACC's, will have its computer capacity increased to enable access to additional support data. A computer to computer link with the JETS will provide automatic update of altimeter information, thus eliminating another manual input. During this period, specifications will be developed for the regional Aeronautical Information Processing System (AIPS), and for scaled down versions of the present Operational Information Display System to meet local (at ATC units) real time sensor derived data, such as wind speed, visibility and status of approach aids.

No major functional changes will be made, during this period, to the Integrated Communications Control System (ICCS). Since the ICCS will, for reasons of obsolescence, need to be replaced by 1992, specifications will be prepared for a functionally similar communications control system. This system will be modularly adaptable to meet the internal (intrafacility) requirements of all ATS facilities.

Studies will be carried out for establishing a central system to handle flow management and airspace reservation requirements. Such a system has potential for reducing existing manual methods of coordination with the Department of National Defence and with the Federal Aviation Administration.

Human factors studies and related engineering development will be started, leading to the operational and technical specification of the future common controller workstation (sector suite). These activities will include continuing development of the weather display system, replacement of flight data strips with electronic tabular displays, and air-ground data link supported ATC operation. Specifications will be developed for replacing the hardware and software, and for upgrading the ATS Research and Experimentation systems. Implementation is scheduled for the late 1980's.

Specifications will be developed for replacement of the ATC training systems at TCTI and for on-site controller training and proficiency evaluation systems. To the maximum extent practicable these systems will be built around the use of common displays, functions, hardware and software.

INTERMEDIATE TERM (TO 1990)

Many important system changes will be made during this period. Most changes will result from incorporating the RAMP radars and by upgrading and enhancing the radar and flight data processing systems.

With introduction of the new radar systems, the display of surveillance information to the controller will be improved. At all major ATC facilities, tracked and (where required) mosaicked PSR and SSR data along with hazardous weather information will be displayed in graphical format to controllers. Outdated display equipment in 19 TWR's and 8 standalone TCU's will be replaced with the new computer based digital display systems. Radar data recording and playback will be provided. The capability for limited on-site controller training and proficiency evaluation will be provided with the new RAMP display systems at the standalone TCU's.

The Flight Data Processing System at each ACC will be expanded and enhanced to provide automatic real time data interchange. These regional systems will be interlinked over the Canadian Aeronautical Digital Network (CADIN) with each other, with all ATS facilities, airlines' flight planning systems and internationally. The automatic transfer of flight plan data will reduce considerably costly existing labour intensive methods. Features, such as system-initiated transfer of control of aircraft and the output of flight strips with accurate fix time estimates, will be provided. These improvements, adapted from GAATS, will provide controllers with accurate planning data to enable computer assisted conflict checking and to allows aircraft to be cleared on fuel efficient profiles.

Apart from expanding the GAATS to serve as its regional Flight Data Processing System, additional functional enhancements for oceanic control will be implemented. Situation displays (geographic), to depict aircraft position information, will be implemented. These displays will provide the controller with dependent surveillance derived aircraft position update. Initially these position reports will be input to GAATS from the Gander Automated FSS and later directly from the HF or Satellite air-ground data link.

During this period the regional Aeronautical Information Processing System will be implemented. When linked to the Canadian Aeronautical Digital Network, it will provide access to its data base by all ATS facilities and users. Similarly, regional Aviation Weather Processors will begin to be implemented at each ACC. From this system real time weather data will be made accessible over the Canadian Aeronautical Digital Network. Weather data will be presented in an easily interpretable graphical format depicting vertical and horizontal cross sections along flight plan routes as well as point and area forecasts.

Implementation of the new Communications Control System at all TWR's and stand-alone TCU's will be started. These systems will provide increased operating flexibility, increased reliability, and will be capable of supporting intrafacility voice and data communications.

Expansion and upgrading of the R&E systems hardware and software will begin. Replacement of the training simulator at TCTI will be started. At the regional and facility level the initial training simulators will be implemented. These systems are a part of the overall program to provide realistic training systems which are capable of being upgraded to reflect actual ATC operations.

Specifications for the centralized Flow Management System will be developed. This system, by matching air traffic demand with airport and terminal control area capacities at selected locations, will provide advance information on where delays are likely to occur and propose alternatives for minimizing them.

LONG TERM (TO 2000)

The major activity during this period will be integrating the capabilities of the several computer based systems into the Advanced Integrated ATC System. By the year 2000, due to the extensive use of automation, the ATC system will be safer, more reliable, more efficient and will contribute an almost doubling in controller productivity.

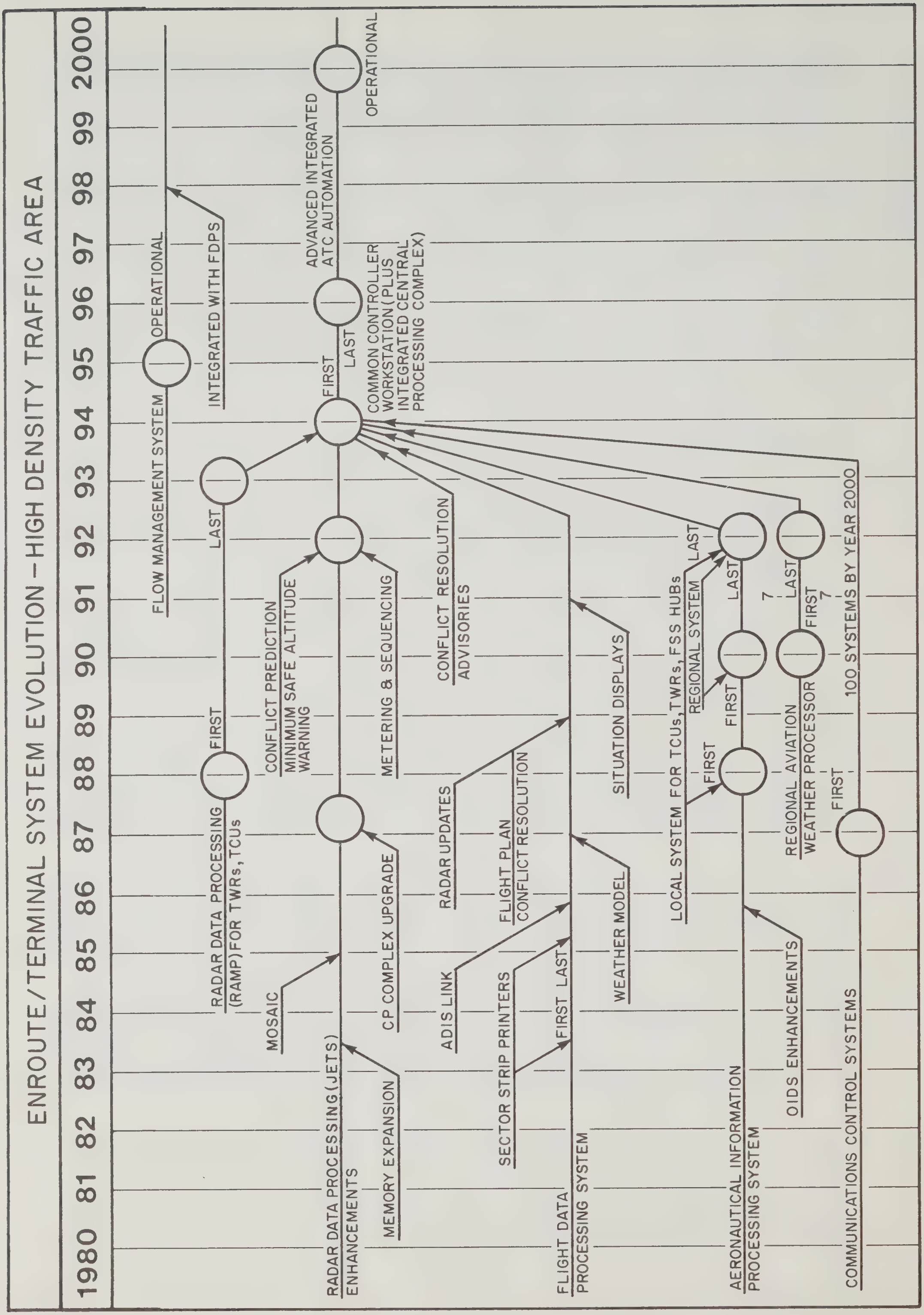
The introduction of the common controller workstation (sector suite) will allow considerable flexibility in ATC sectorization and management of the airspace under a controller's jurisdiction. The scope offered by the technical framework of the plan will offer several alternatives for operational exploitation and personnel utilization.

Functions which are necessary for such operation will be implemented. These include conflict prediction and resolution, minimum safe altitude warning, flow management options and metering and sequencing in terminal control areas. Features critical to maintaining a minimum safe level of air traffic control service will be implemented at each sector suit.

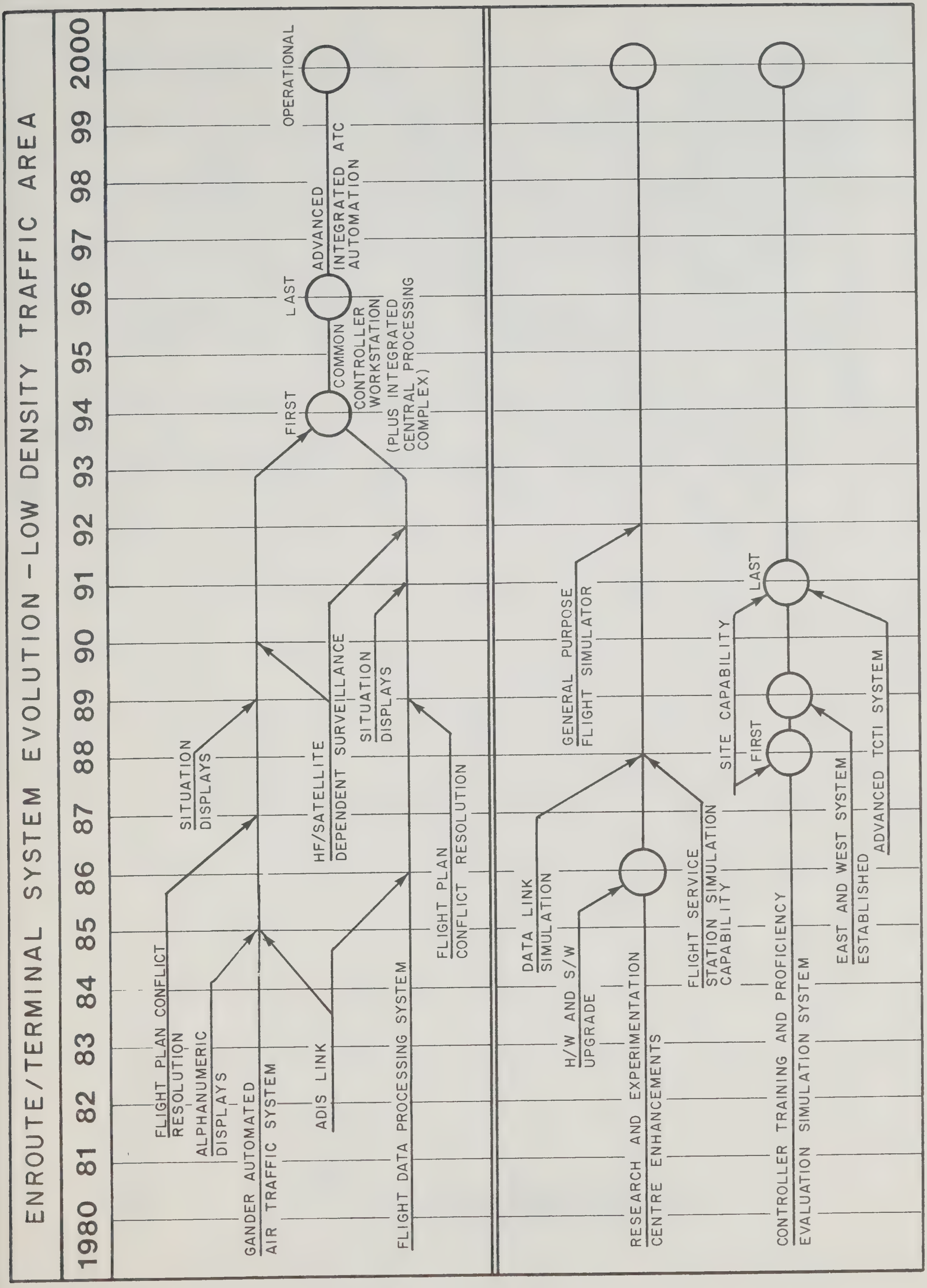
The common controller workstation, based on two main air traffic situation displays will be implemented. Flight Strips will be replaced by electronic tabular displays. Local area networks will interlink all sector suites and the central computer complexes.

The SSR system will be upgraded to Mode S. This mode permits the discrete addressing of aircraft and communications via air-ground data link. It will also provide improved surveillance information and enable the automatic transfer of information between aircraft and ATC systems. In the low density traffic area, where Mode S coverage is not available, HF or Satellite air-ground data link will provide similar capabilities.

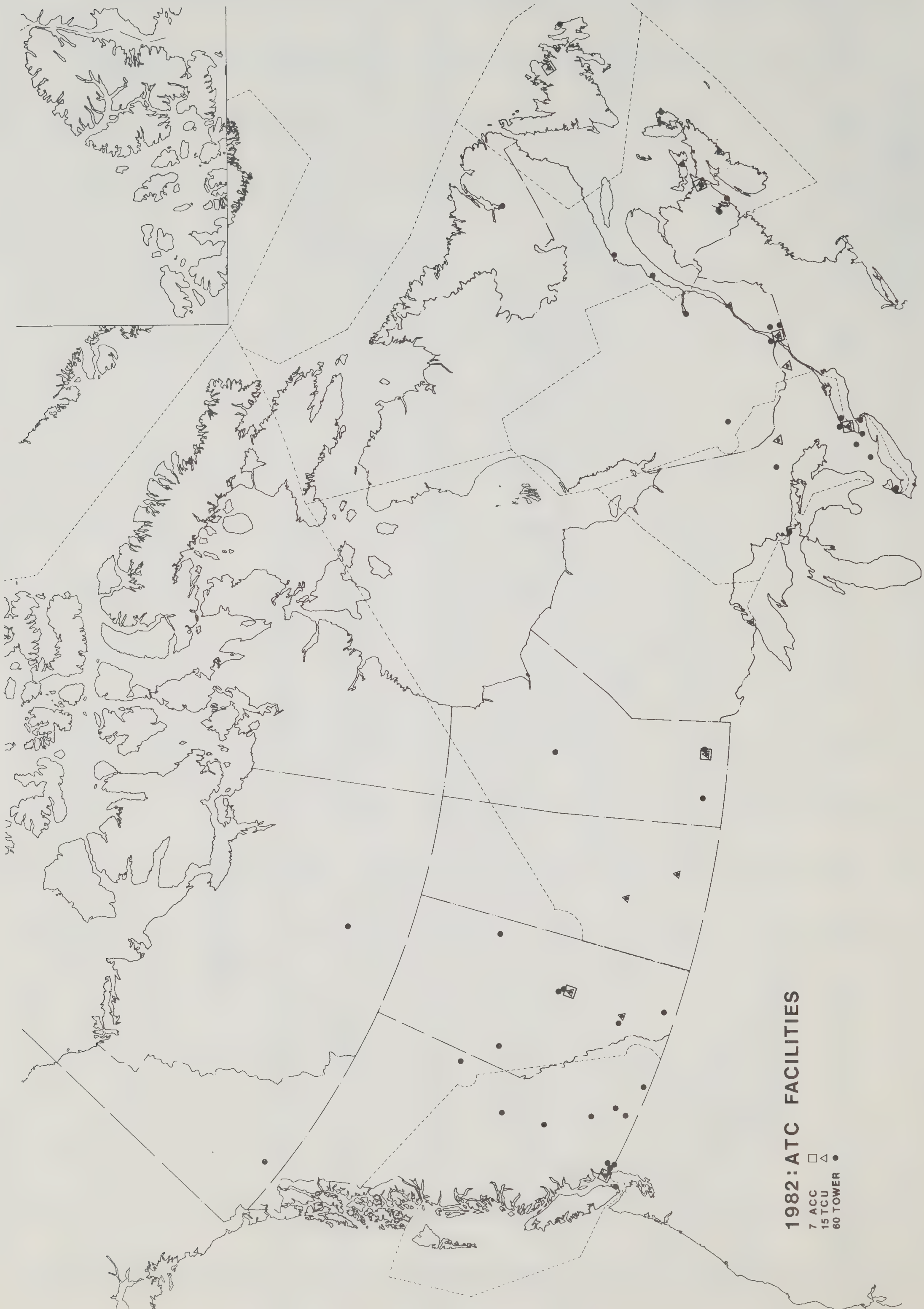
Towards the end of the period the Flow Management System will become operational. Initially, controllers will be provided with advisories on traffic congestion delays, but eventually the system will be on-line with the regional Flight Data Procesing Systems. The system will provide automatic determination of alternative clearances to minimize costly fuel delays.



ENROUTE/TERMINAL SYSTEM EVOLUTION - HIGH DENSITY TRAFFIC AREA
1980
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
2000
FLOW MANAGEMENT SYSTEM
OPERATIONAL
INTEGRATED WITH FDPS
OPERATIONAL
RADAR DATA PROCESSING (RAMP) FOR TWRs, TCUs
FIRST
LAST
MOSAIC
RADAR DATA PROCESSING (JETS) ENHANCEMENTS
MEMORY EXPANSION
CP COMPLEX UPGRADE
CONFLICT PREDICTION
MINIMUM SAFE ALTITUDE WARNING
METERING & SEQUENCING
CONFLICT RESOLUTION ADVISORIES
FIRST
LAST
COMMON CONTROLLER WORKSTATION (PLUS INTEGRATED CENTRAL PROCESSING COMPLEX)
ADVANCED INTEGRATED ATC AUTOMATION
ADIS LINK
RADAR UPDATES
FLIGHT PLAN CONFLICT RESOLUTION
SECTOR STRIP PRINTERS
FIRST
LAST
FLIGHT DATA PROCESSING SYSTEM
WEATHER MODEL
SITUATION DISPLAYS
LOCAL SYSTEM FOR TCUs, TWRs, FSS HUBs
FIRST
FIRST
REGIONAL SYSTEM
LAST
LAST
AERONAUTICAL INFORMATION PROCESSING SYSTEM
OIDS ENHANCEMENTS
REGIONAL AVIATION WEATHER PROCESSOR
FIRST
7
LAST
7
FIRST
COMMUNICATIONS CONTROL SYSTEMS
100 SYSTEMS BY YEAR 2000



ENROUTE/TERMINAL SYSTEM EVOLUTION - LOW DENSITY TRAFFIC AREA
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
GANDER AUTOMATED AIR TRAFFIC SYSTEM
FLIGHT PLAN CONFLICT RESOLUTION
ALPHANUMERIC DISPLAYS
ADIS LINK
SITUATION DISPLAYS
HF/SATELLITE DEPENDENT SURVEILLANCE
SITUATION DISPLAYS
FLIGHT DATA PROCESSING SYSTEM
FLIGHT PLAN CONFLICT RESOLUTION
FIRST
LAST
COMMON CONTROLLER WORKSTATION (PLUS INTEGRATED CENTRAL PROCESSING COMPLEX)
ADVANCED INTEGRATED ATC AUTOMATION
OPERATIONAL
RESEARCH AND EXPERIMENTATION CENTRE ENHANCEMENTS
H/W AND S/W UPGRADE
DATA LINK SIMULATION
FLIGHT SERVICE STATION SIMULATION CAPABILITY
GENERAL PURPOSE FLIGHT SIMULATOR
CONTROLLER TRAINING AND PROFICIENCY EVALUATION SIMULATION SYSTEM
EAST AND WEST SYSTEM ESTABLISHED
ADVANCED TCTI SYSTEM
SITE CAPABILITY
FIRST
LAST


1982: ATC FACILITIES
7 ACC □
15 TCU △
60 TOWER ●

BENEFITS OF THE PLAN

Expanding the use of automation will result in an upgraded ATC system and will serve as the basis for significant improvements in air safety. In the foreseeable future, those routine and repetitive tasks which add to the controller's workload and which limit his traffic management capacity will be systematically transferred to automated systems. This process will take several years to accomplish. By increasing controller productivity through the use of automation it will be possible to accommodate the increase in air traffic demand without a corresponding increase in the number of controllers. By exploiting the potential of automation and through systems integration, considerably greater reliability and flexibility will be realized. The most important benefit of the measures described in this plan, in terms of the controller's work environment, will be in providing a considerably higher level of job satisfaction.

Personnel requirements and operations and maintenance costs are not expected to increase significantly over the period of this plan (to the year 2000). If the implementation of the plan proceeds on schedule it is expected that personnel requirements for providing ATC services will level off at about 2800 by the year 2000.

SUMMARY OF CHANGES

1985 - No substantial changes will be made to the existing ATC system except for a series of modifications to the radar data processing system (JETS) to ensure its interoperability with the new (RAMP) radar systems. Equipment used in TWR's and stand-alone TCU's will remain unchanged. The nucleus flight data processing system will be implemented at all ACC's. Some resource alignment will be carried out during this period and no growth in the personnel required for the provision of ATC services (currently at 2710) is projected.

1990 - During this period implementation of the new (RAMP) radar systems will begin. At the 19 selected TWR's and the 8 stand-alone TCU's modern display systems will begin to provide significant operational improvement. By 1990 the ATC system will be at the mid-point of the radar replacement program and can expect to face problems typical of periods of transition where both old and new systems will continue to be used.

To cope with these transition problems and to meet increased air traffic growth and demands for services a slight temporary growth in ATC strength from 2710 to about 2875 (about 6 per cent) is projected. This projection is based on experience both in Canada and abroad where major systems improvements have been carried out. It stems from having to implement the "new" system, methods and procedures whilst continuing to use the "old" system in the provision of services without disruption and without compromising safety. The transition phase is also expected to result in a slight temporary increase in operations and maintenance costs. This limited growth assumes the realization of improvements in automating several flight data processing and distribution functions together with on-line data transfer through improved interfacility communications.

2000 - By 1993 the radar replacement program will be completed. The regional flight data processing system will have been fully implemented and through upgraded interfacility communications will be accessible, on-line, by all ATS facilities and aircraft operating agencies. Implementation of the common controller workstation (sector suite) will be one of the most important features of the modernized ATC system. These workstations will contribute towards increased controller productivity, flexibility of operation and, because of the built-in autonomous processing capability, will have very high reliability.

These improvements, together with implementation of the regional aeronautical and aviation weather processing systems, will see the realization of the benefits of the plan. As the planned levels of automation of the ATC system are completed and as greater controller productivity is realized, a levelling off or a slight decrease in ATC strength from 2875 to 2800 is projected against, by the year 2000, an 80% growth in the demand for air traffic services.

PROGRAM	IMPLEMENTATION	
	1st	Last
1. Radar Data Processing System (JETS) Enhancements	1983	1988
2. Gander Automated Air Traffic System (GAATS) Enhancements	1983	1990
3. Flight Data Processing System (FDPS)	1983	1992
4. Radar Data Processing System (RAMP) for TCU's/TWR's	1987	1993
5. Aeronautical Information Processing System (AIPS)	1983	1992
6. Regional Aviation Weather Processor (See Chapter 5)	1990	1992
7. Communications Control System (CCS)	1987	2000
8. Conflict Prediction and Minimum Safe Altitude Warning	1992	1993
9. Conflict Resolution Advisory	1994	1994
10. Metering and Sequencing	1992	1994
11. Common Controller Workstation (Sector Suite)	1994	1996
12. Flow Management System	1995	
13. Advanced Integrated ATC System	1996	2000
14. Research and Experimentation System Enhancements	1987	
15. Controller Training and Proficiency Evaluation Simulation System	1988	1993

PROJECT: RADAR DATA PROCESSING SYSTEM (JETS) ENHANCEMENTS

PURPOSE: To increase the capacity of the present systems (JETS) located in the ACC's in order to handle forecast air traffic growth, and to improve processing of data derived from existing radar systems. To upgrade the Central Processing Complex (including the tracking processor), and Display Processors (new hardware and software) of the JETS in order to meet the expanded data processing demands of the new RAMP radar systems, and to accommodate future enhancements in ATC automation.

Immediate measures must be taken to increase the capacity (computer memory) of the present JETS to meet short term operational requirements. Studies have also shown that the Central Processing Complex will need to be replaced (with new processors) before the RAMP radar systems are implemented. With the change in hardware, the system's software will be translated into a High Level Language and will result in a significant reduction in software maintenance effort. The capacity (memory) of the Display Processors will also be expanded to handle increased data from the RAMP radar systems.

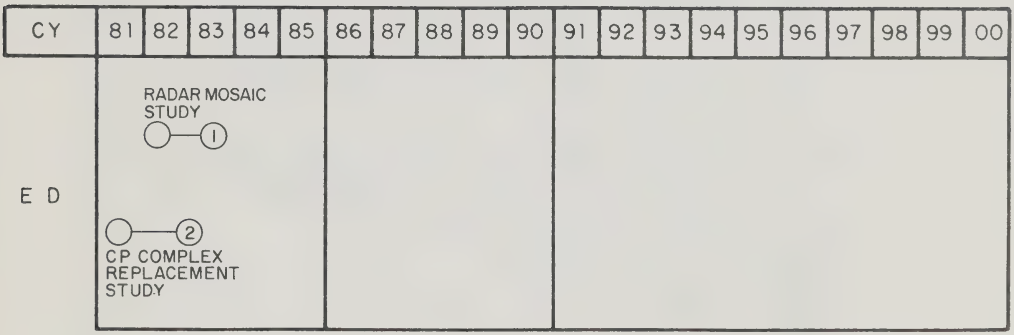
APPROACH: Initially, the memory of all JETS processors will be doubled. This will be carried out on the Central Processors, Tracking Processors and then on the Display Processors. Software to provide improved radar data display derived from overlapping radars through mosaicking or multitracking, will be introduced as soon as possible. Beginning in 1984, replacement of the Central Processors and Tracking Processors with plug-compatible processors will be carried out. Software of the present system will be translated into a high level language. This upgrade will provide a basic Radar Data Processing System which is easily enhanced and expanded and offers all the advantages of high level languages.

QUANTITIES: All 7 operational JETS plus the (DMC) maintenance and (TCTI) training systems will be upgraded.

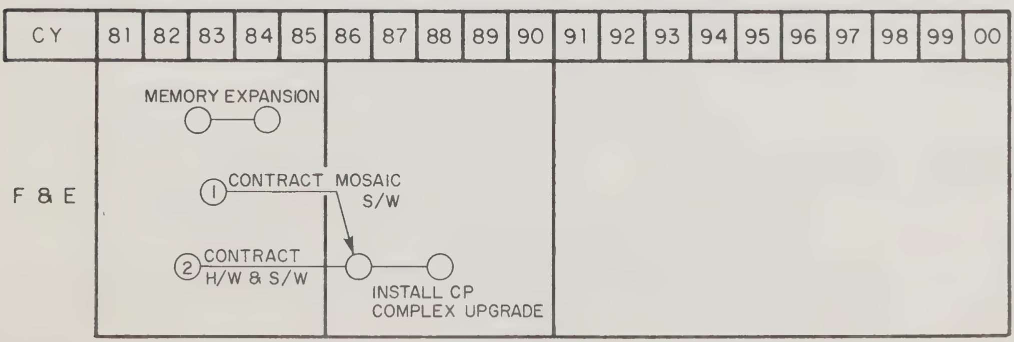
RELATED PROJECTS/ACTIVITIES:

- Radar Modernization Project (RAMP)
- Radar Data Processing (RAMP) for TCU's/TWR's
- Conflict Prediction/Minimum Safe Altitude Warning
- Metering and Sequencing
- Advanced Integrated ATC System
- Research and Experimentation System Enhancements
- Controller Training and Proficiency Evaluation Simulation System/s.
- Common Controller Workstation (Sector Suite).

SCHEDULE



SCHEDULE



PROJECT: GANDER AUTOMATED AIR TRAFFIC SYSTEM (GAATS) ENHANCEMENTS

PURPOSE: To upgrade the capacity and functional capability of the present system in order to meet operational requirements and internationally identified changes.

The present system provides controllers with accurate flight time estimates, air traffic conflict prediction, and minimum time track data. These features enable controllers to assign to aircraft conflict free profiles with some fuel savings. The system is linked to the Aeronautical Fixed Telecommunications Network and to the JETS, and automatically exchanges data with the oceanic system in Prestwick. Enhancements will enable controllers to provide aircraft within or outside the Organized Track Structure with improved fuel efficient flight profiles.

Aircraft positional information, read directly from the onboard navigation system, will be relayed via HF or Satellite air-ground data link to the ATC system and presented to controllers on geographic displays. This will permit the application of reduced separation and the use of tactical control, thus improving overall operating efficiency.

APPROACH: The performance and capacity of the present system will improve with the implementation of more efficient software. An interface to the Aeronautical Fixed Telecommunications Network will provide automatic input of flight plan data and input of aircraft position reports relayed from the Gander Flight Service Station. The system will be expanded to handle domestic flight data processing requirements. Conflict prediction on westbound air traffic and conflict resolution software will be added. Improvements in the weather model will make the system more sensitive to providing fuel efficient profiles. Displays will be provided to automatically depict the dependent surveillance derived real time aircraft positional data relayed via the HF and Satellite data link system. Flight data strips will be replaced with electronic data displays. Other labour-intensive functions, such as planning the Organizing Track Structure, clearance delivery and conflict resolution will be automated.

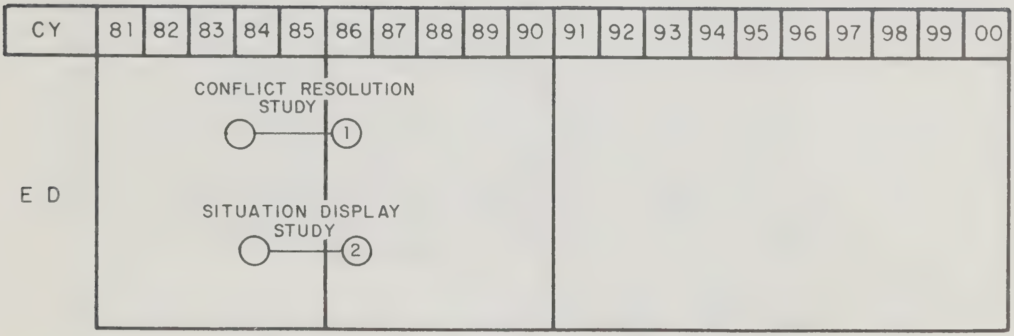
Operating concepts, equipment and software developed on this system will be applied to the Flight Data Processing System.

QUANTITIES: Upgrading one system.

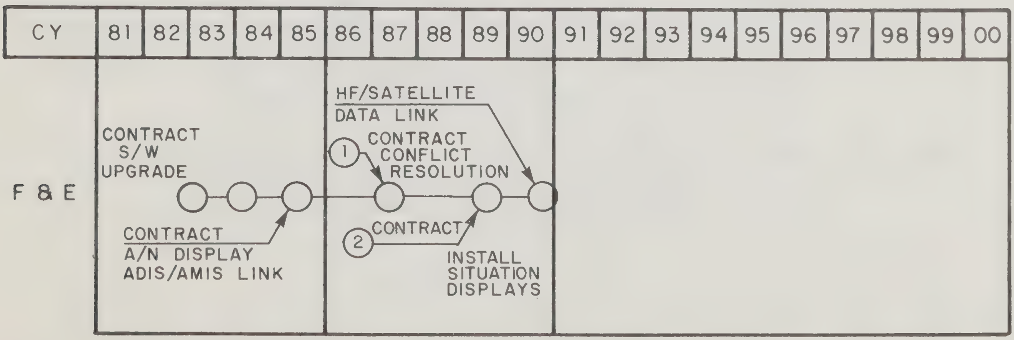
RELATED PROJECTS/ACTIVITES:

- Flight Data Processing System
- Data Link for Dependent Surveillance
- Common Controller Workstation (Sector Suite)
- Gander Automated FSS (GAFSS).

SCHEDULE



SCHEDULE



PROJECT: FLIGHT DATA PROCESSING SYSTEM

PURPOSE: To provide a standardized Flight Data Processing System (FDPS) at each Area Control Centre capable providing strategic air traffic control operations throughout Canada's domestic airspace.

The present labour intensive means of processing and transferring flight plan data is inefficient, costly and time consuming. Several different systems are used in each ACC and none are interlinked. The future Flight Data Processing System will provide automatic and timely processing and transfer of flight data between all ATS facilities and airlines. Accurate estimates of flight times, conflict probe and resolution, automatic generation of ATC clearances, data for strategic flow management, and statistical data will also be provided. These capabilities will increase controller productivity and the systems capacity to cope with the growth in air traffic. Benefits to users will be realized through reduced delays, reduced routing restrictions and more fuel efficient operations.

APPROACH: The Flight Data Processing System located at each Area Control Centre, will evolve to support the flight data processing requirements for all ATS facilities and users within the Flight Information Region. Initial upgrading of the Flight Data Processing System will improve flight data distribution, provide links with the Radar Data Processing System, provide local and remote controller workstation printers, incorporate a weather model for the calculation of accurate flight time estimates, and provide automatic transfer of arrival/departure data. At selected TWR's, FSS Hubs and stand-alone TCU's intelligent input/output devices will be provided and will be linked with the Flight Data Processing System. User's (Airlines) flight planning systems will be tied into the Flight Data Processing System.

Additional enhancements will include automatic updating of the Flight Data Processing System with aircraft real time position data derived from the Radar Data Processing System or from the surveillance systems. This function is a prerequisite to providing improved strategic flow management, conflict resolution, optimum fuel efficient flight profiles and the implementation of the Advanced Integrated ATC System by the year 2000. The weather model will also be improved to include information on hazardous weather.

QUANTITIES: Eight systems, one at each ACC. The GAATS will serve both oceanic and domestic flight data processing requirements. One at the DMC for maintenance (configuration management and control) and one at TCTI for training.

RELATED PROJECTS/ACTIVITIES:

- Gander Automated Air Traffic System
- Conflict Prediction/Minimum Safe Altitude Warning
- Common Controller Workstation (Sector Suite)
- Flow Management System
- Advanced Integrated ATC System
- Data Link for Dependent Surveillance
- FSS Workstation
- Direct User Access Terminal
- Radar Data Processing System.

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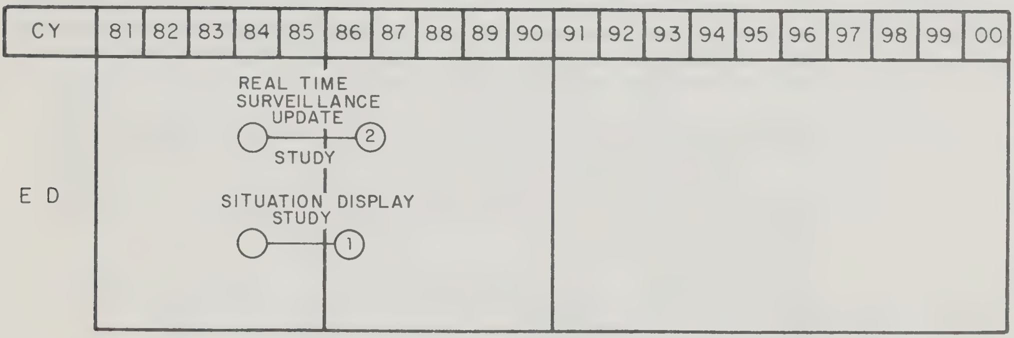

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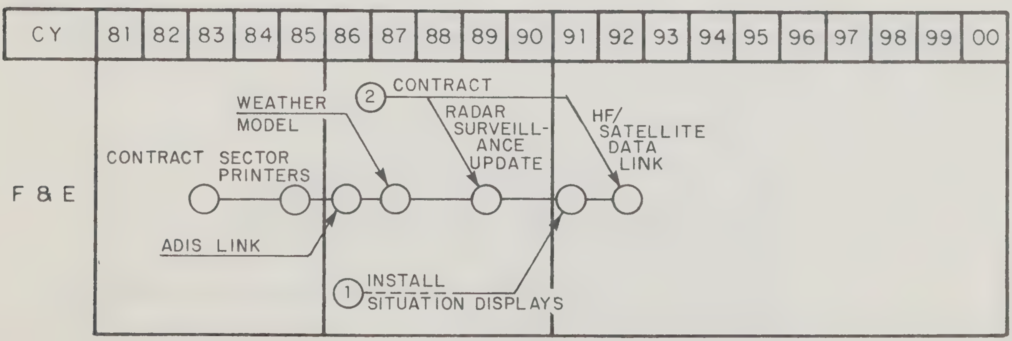


PROJECT: RADAR DATA PROCESSING SYSTEM (RAMP) FOR TCU's AND TWR's

PURPOSE: To provide ATC with modern computer based radar data processing and display systems for TWR's and stand-alone TCU's.

Systems and equipment now in use at stand-alone TCU's and at the busier TWR's consists of outdated plan position indicators and scan-converted (TV-type) displays. The systems are 20 or more years old and are not computer driven. Radar data are displayed in analog format, without aircraft identity tags or altitude information, requiring controllers to mentally maintain the association between the displayed target and its identify. This limits the number of aircraft that a controller can manage.

The new Radar Data Processing System will display radar-derived aircraft positions automatically associated with identity, altitude and speed. The system will effect automatic transfer of control of aircraft. Other pertinent data will be displayed in digital format thereby enabling normal lighting to be used in the ATC operations environments. Daylight viewing displays will be provided in TWR's.

APPROACH: The design, development, testing and installation of these automated systems is part of the Radar Modernization Project. The systems will consist of processor-based display systems communicating via a local area network. Through the use of distributed processing each display unit will be capable of autonomous operation and will provide a highly reliable and available system. Modular expansibility of these Radar Data Processing System (RAMP) display units will be a design requirement as it is planned to use these units to develop the main situation display of the Common Controller Workstation.

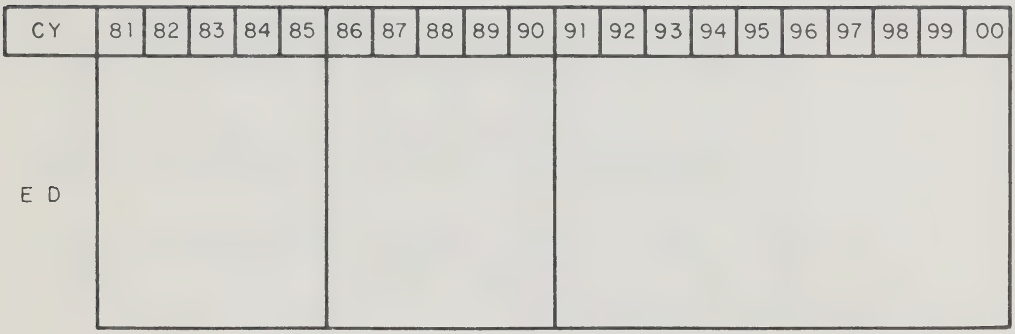
To the maximum extent practicable common hardware and software will be provided in TCU's and selected TWR's. The capability for limited on-site controller training and proficiency evaluation will be provided on these systems.

QUANTITIES: Approximately 120 display units will be acquired for the 60 TWR's and 8 stand-alone TCU's plus one system for the DMC and one for TCTI.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization PROJECT (RAMP)
- Radar Data Processing (JETS) Enhancements
- Common Controller Workstation (Sector Suite)
- Conflict Prediction/Minimum Safe Altitude Warning
- Metering and Sequencing
- Controller Training and Proficiency Evaluation Simulation System/s
- Communications Control System.

SCHEDULE



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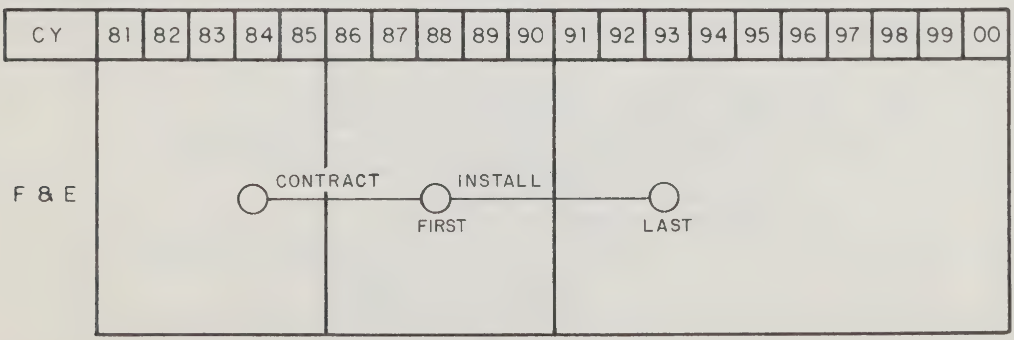

PROJECT: AERONAUTICAL INFORMATION PROCESSING SYSTEM

PURPOSE: To provide essential aeronautical information on a timely basis to all ATS facilities, pilots and aircraft operating agencies.

The provision of accurate and timely aeronautical information is essential to ensure safe and efficient air traffic control. Currently, the Operational Information Display System, located in each ACC, provides aeronautical data (both real time sensor-derived and stored) to all controller workstations. The system's capacity is limited and it uses outdated computer technology. Apart from the ACC's and their colocated TCU's and TWR's, no similar capability exists at other ATS facilities. As a part of modernizing the ATS system and improving efficiency, the capability of the Operational Information Display System will be provided at all ATS facilities.

APPROACH: Activity is underway to enhance functions and to increase computer capacity. Action will be initiated to reorientate the development of the Operational Information Display System to reflect the expanded requirement for region-wide on-line access to aeronautical information.

In effect, the new approach, will be to provide all ATS facilities with "local" aeronautical information, including real time sensor derived data such as windspeed and direction, altimeter setting, runway visual range, and status of navigation and approach aids. Other non real time critical data will be stored in the regional Aeronautical Information Processing System at each ACC and will be accessible by all ATS facilities and aircraft operating agencies.

At each ACC, a regional Aviation Weather Processing System will serve as a data base accessible by all ATS facilities and aircraft operating agencies within the Flight Information Region.

QUANTITIES: 7 Aeronautical Information Processing Systems for the ACC's.
3 systems for use at the DMC, TCTI and the R&E Centre.

RELATED PROJECTS/ACTIVITIES:

- NOTAM System Automation
- Regional Aviation Weather Processing System
- Automated Weather Observing and Reporting System
- Canadian Aeronautical Digital Network
- Common Controller Workstation
- FSS Workstation.

SCHEDULE

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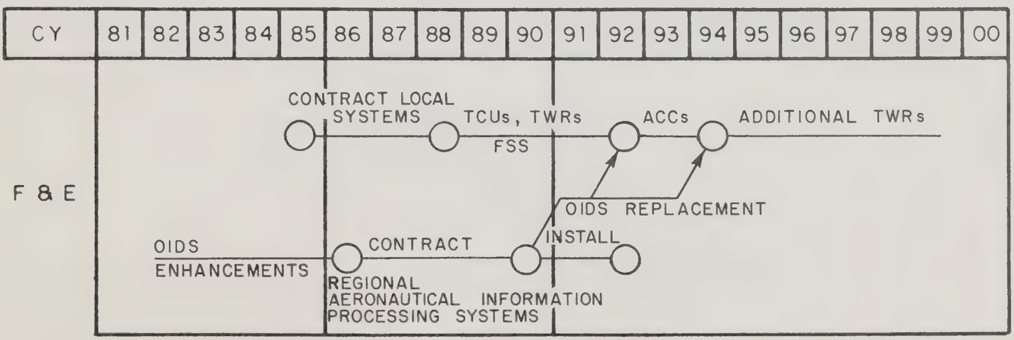
SCHEDULE



PROJECT: COMMUNICATIONS CONTROL SYSTEM

PURPOSE: To provide, at all ATS facilities, a modern voice switching and Communications Control System.

This system will provide the intrafacility voice links, as well as the interfacility and ground-air voice communications interface. This system will initially replace non-standard, obsolete and non-reconfigurable voice communications equipment. Implementation of this system will reduce costs, enhance operating efficiency and accommodate voice and data.

APPROACH: The Communications Control Systems for TCU's, TWR's and FSS's, will use commercially available systems adapted to ATS operational requirements. Provision will be made for a digital interface with the Controller and FSS Workstations and the Canadian Aeronautical Digital Network. The system will allow reconfiguration of communications consistent with operational needs and will provide internal diagnostics and redundancy to reduce maintenance workload and system outages. System utilization and recording of transactions will be included. The design will be modular to support various sized ATS facilities.

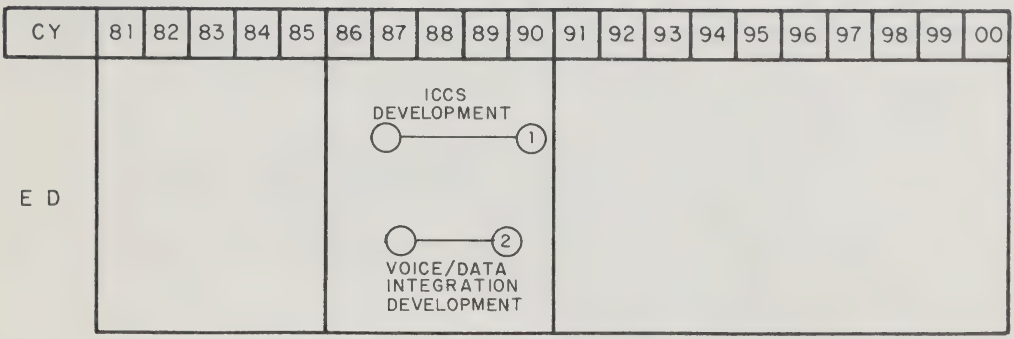
The Communications Control System for Area Control Centres will be a more advanced version and will replace the Integrated Communications Control System by 1993. This system will incorporate additional features such as local area network techniques and voice and data switching.

QUANTITIES: Approximately 95 systems (involving some 250 workstations) will be included in the first day. An additional 10 systems to replace the Integrated Communications Control Systems at the ACC's, R&E Centre, DMC and TCTI will also be acquired (1993).

RELATED PROJECTS/ACTIVITIES:

- Canadian Aeronautical Digital Network
- Common Controller Workstations
- FSS Workstation
- Integrated Intrafacility Network.

SCHEDULE



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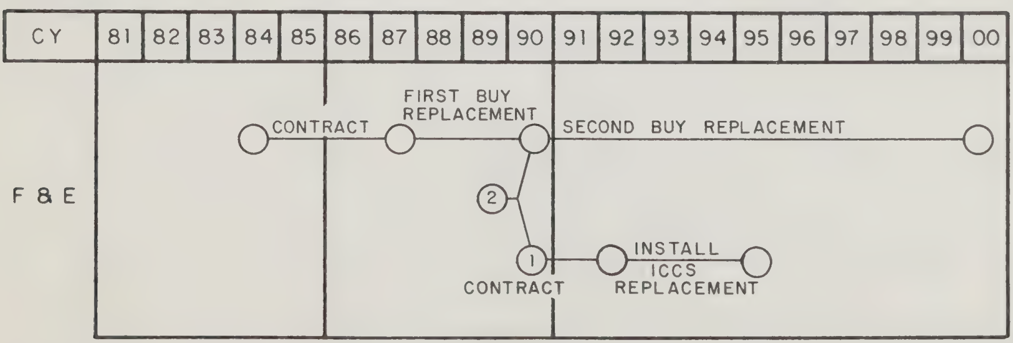


PROJECT: CONFLICT PREDICTION AND MINIMUM SAFE ALTITUDE WARNING

PURPOSE: To provide controllers with computer generated conflict prediction alerts and minimum safe altitude warnings.

These functions will assist controllers by identifying potential conflict situations between Mode C transponder equipped aircraft, as well as alerting controllers to aircraft ground proximity situations.

These enhancements are prerequisites to computer generated conflict resolution advisory. The inclusion of these conflict prediction functions will provide added system safety during the period of increasing growth in air traffic.

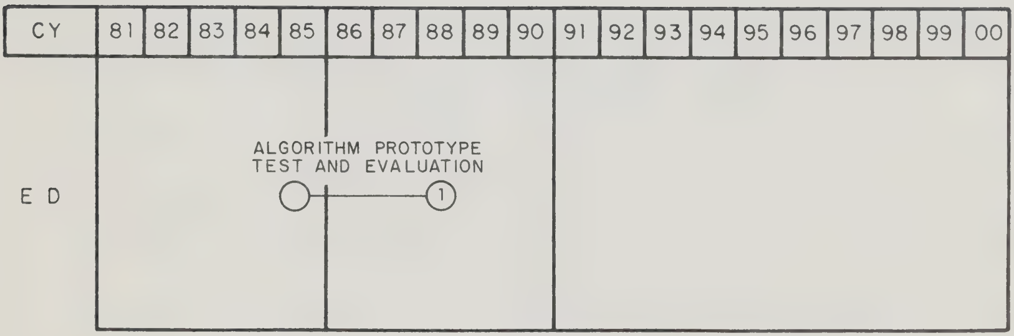
APPROACH: Software to perform these functions will be developed and implemented in the central processing complex of the Radar Data Processing Systems at the ACC's. At stand-alone TCU's hardware will be added to incorporate common software for providing conflict prediction and minimum safe altitude warning functions which will be distributed to the controller workstations via the local area network.

QUANTITIES: One high level language software package. The software will be usable by the RDPS, FDPS, R&E Centre, DMC, TCTI, and in the Controller Training and Proficiency Evaluation Systems. The software package will also be used in the stand-alone TCU's.

RELATED PROJECTS/ACTIVITIES:

- Radar Data Processing System (JETS) Enhancements
- Radar Data Processing System ((RAMP)
- Flight Data Processing
- Gander Automated Air Traffic System
- Conflict Resolution Advisory
- Flow Management System.

SCHEDULE



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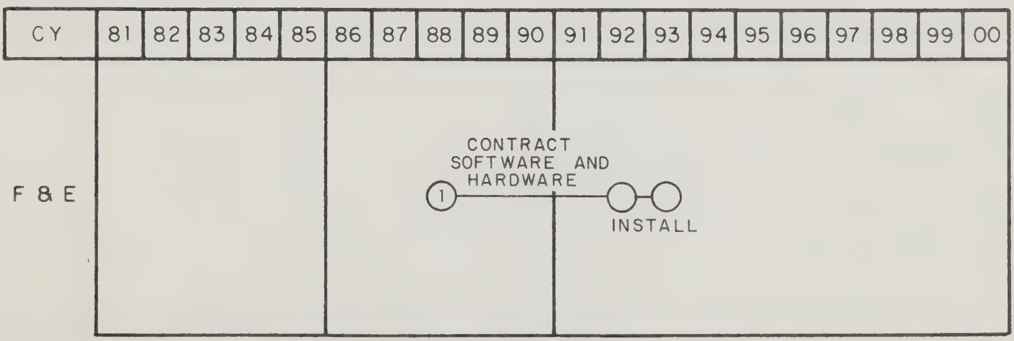


PROJECT: CONFLICT RESOLUTION ADVISORY

PURPOSE: To provide controllers with computer generated aircraft conflict resolution advisories (alternatives) when violation of separation minima is about to occur. The objective of this function is to reduce the number of system errors (losses of separation).

With the forecast growth in air traffic and complexity of operations associated with providing aircraft fuel efficient direct routes, this function will be an essential aid to the controller.

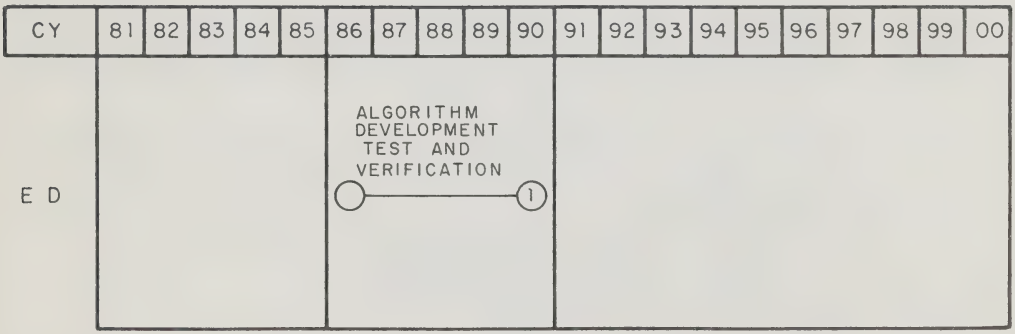
APPROACH: The inclusion of conflict resolution advisory will need to be studied in the context of the changing role of the controller and the highly automated ATC environment. Based on functional specifications, engineering development of a prototype will be evaluated at the R&E Centre before the acquisition of software packages for implementation in operational systems. The operational implementation of this function is a prerequiusite for the Advanced Integrated ATC System.

QUANTITIES: One software package for adaptation and use at the ACC's and TCU's.

RELATED PROJECTS/ACTIVITIES:

- Conflict Prediction and Minimum Safe Altitude Warnings
- Advanced Integrated ATC System.

SCHEDULE



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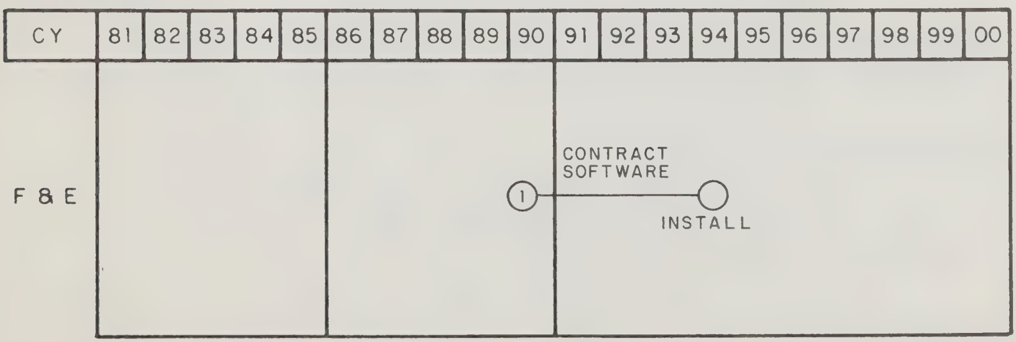


PROJECT: METERING AND SEQUENCING

PURPOSE: To provide the controller with computer generated assistance in order to support efficient and expeditious management of air traffic and to optimize the traffic flow during the arrival and departure phases of flight.

In the complex air traffic environment of Terminal Control Area operations (involving climbing, turning, acccelerating, decelerating and descending traffic), the optimization of traffic flow is necessary to avoid undue delay whilst maintaining safety. Metering and sequencing software will continuously model and predict the traffic situation, provide control information and traffic sequencing to the controller, and will be sensitive to parameters such as, runway capacity, weather conditions, and wake turbulence. The software will provide an automated interface with enroute air traffic (Flow Management System).

APPROACH: Developmental activity at the R&E Centre will lead to the design and specification of software and its extensive testing before it is adapted for operational use in all TCU's. Since the software (algorithm), in its final form, is likely to be complex, it is proposed to develop the capability for metering and sequencing in phases.

Phase 1 - The development of the system (metering and sequencing) and operational concept for a stand alone runway capacity traffic management system.

Phase 2 - Expansion of the initial capability through development of a Terminal Control Area planning aid which will include:

- Runway capacity traffic management.
- Airspace configuration management.
- Arrival flow planning (sequencing).
- Departure flow planning (metering).

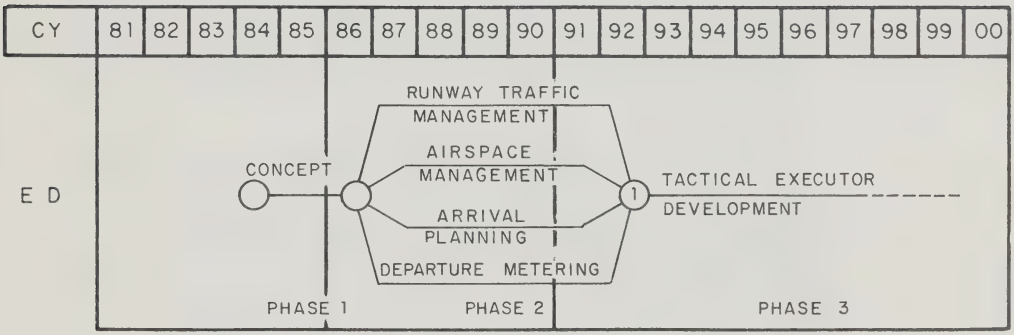
Phase 3 - Development of a Terminal Control Area Tactical Executor which will automatically generate clearances and directives (data linked to aircraft).

QUANTITIES: Following development, one software package for each phase for use in all TCU's.

RELATED PROJECTS/ACTIVITIES:

- Radar Data Processing System (JETS) Enhancements
- Radar Data Processing System (RAMP)
- Flight Data Processing System
- Flow Management System
- Advanced Integrated ATC System.

SCHEDULE



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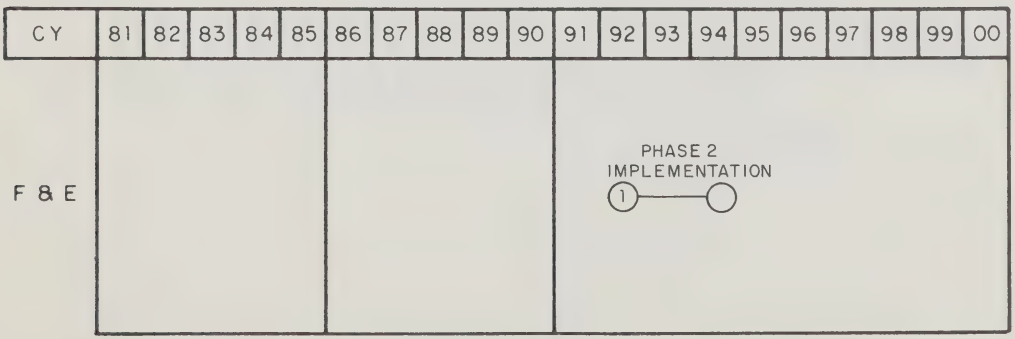


PROJECT: COMMON CONTROLLER WORKSTATION (SECTOR SUITE)

PURPOSE: To provide an integrated and versatile Common Controller Workstation (sector suite) capable of being operated by one controller.

The sector suite will result in significantly increased controller productivity, and the combination of the central computer complex, distributed processing and partitioned software will provide increased system efficiency, reliability and availability.

APPROACH: Common Controller Workstations will be developed which will provide controllers with electronic display of digital radar data, flight plan data, weather data, and supplementary aeronautical information. Down-sized versions of the sector suites (except for the displays) will be provided in TWR's, where daylight viewing displays will be used.

Air traffic situation displays (geographical and tabular), a planning and probe display, auxiliary displays and suitable interactive (touch-input) devices will constitute the controller workstation. Each workstation suite will be capable of operating autonomously in the event of failure of the central computer complex. The integrated system will be based on a central computer complex and distributed processing at each sector suite. This system performs radar data processing, flight data processing, aeronautical data management and weather data processing. Multi-busses will carry data between the central computer complex and the sector suites.

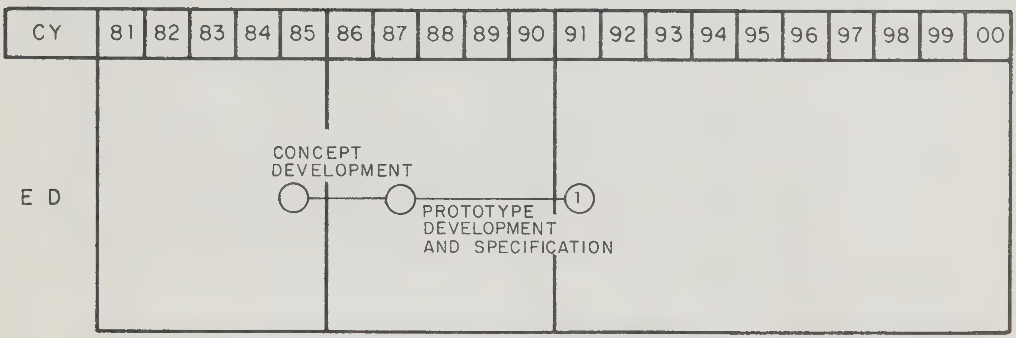
In conjunction with development of the controller workstation, the software of the central computer complex will be reorganized and redistributed to ensure that critical air traffic surveillance data will always be available at the workstation. The central computer complex will be capable of expansion to accommodate future ATC enhancements. Previous separate hardware systems (RDPS, FDPS, etc) will eventually evolve into this integrated complex thereby eliminating redundant activities and improving overall system performance.

QUANTITIES: 250 Common Controller Workstations
7 Integrated Central Processing Complexes for the ACC's
2 Integrated Central Processing Complexes for the DMC and TCTI.

RELATED PROJECTS/ACTIVITIES:

- FSS Work Stations
- Aeronautical Information Processing System
- Aviation Weather Processor
- Radar Data Processing System
- Flight Data Processing System
- Integrated Intrafacility Network
- Communications Control System
- Advanced Integrated ATC System
- Controller Training and Proficiency Evaluation System.

SCHEDULE



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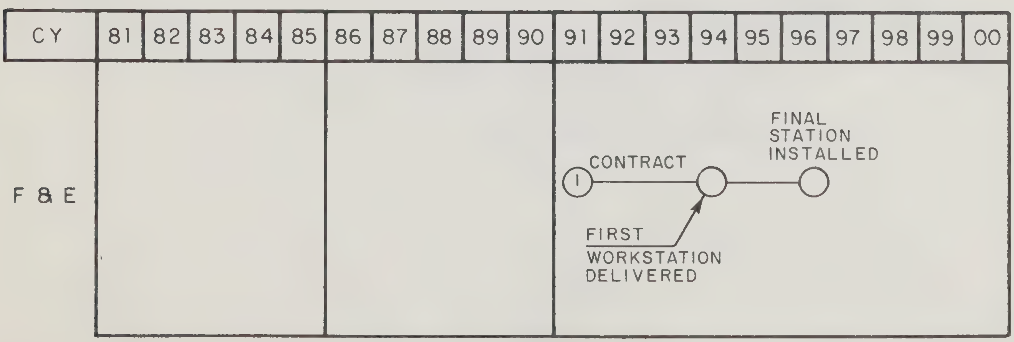


PROJECT: FLOW MANAGEMENT SYSTEM

PURPOSE: To provide a centralized Flow Management System for the dissemination of predicted and real time flow restriction information and airspace reservation information. This information is required by:

- Airspace users, in flight planning;
- ATC for adjusting in-flight profiles in order to minimize air traffic delays and to allow fuel efficient operations.

In order to refine the provision of strategic clearances to traffic, flow management at busier locations will have to be implemented by 1995. The implementation of this system will permit strategic planning to be effected to adjust the flow of traffic and absorb delays in a more fuel efficient manner. The system will also handle Department of National Defence requirements for airspace and altitude reservation and will match these requirements against the free flight or area navigation type profiles that will be the preference of airspace users.

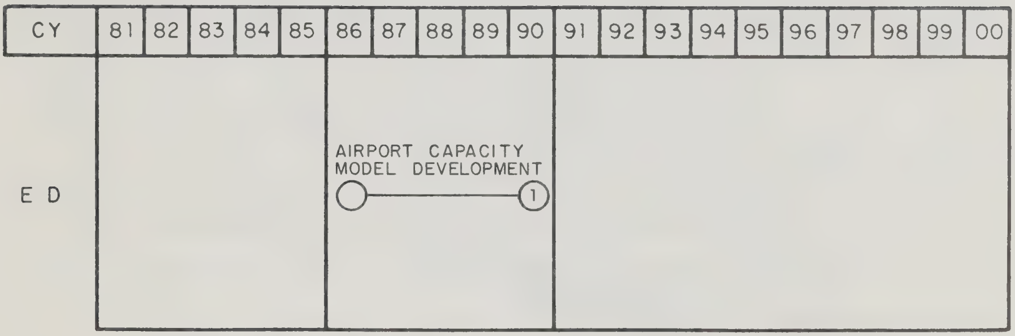
APPROACH: Initial activity will be directed to the development of an airports capacity model capable of analyzing planned flight operations (arrivals and departures) in relation to airport (airside) capacities and forecast weather conditions. When implemented, the Flow Management System will disseminate acceptance rate data for airports to the ACC's, to be used in organizing air traffic to accommodate delays through earlier (en route) changes in flight profiles. Subsequent improvements to this system will allow the automatic transfer of information between Flight Data Processing Systems at ACC's, the flight planning systems of airlines, and with the FAA (US). When the Advanced Integrated ATC System is achieved, the Flow Management System will provide information for the automatic determination of strategic clearances.

QUANTITIES: One Flow Management System will be developed and installed at a central location.

RELATED PROJECTS/ACTIVITIES:

- Flight Data Processing System
- Advanced Integrated ATC System
- Canadian Aeronautical Digital Network
- Metering and Sequencing.

SCHEDULE



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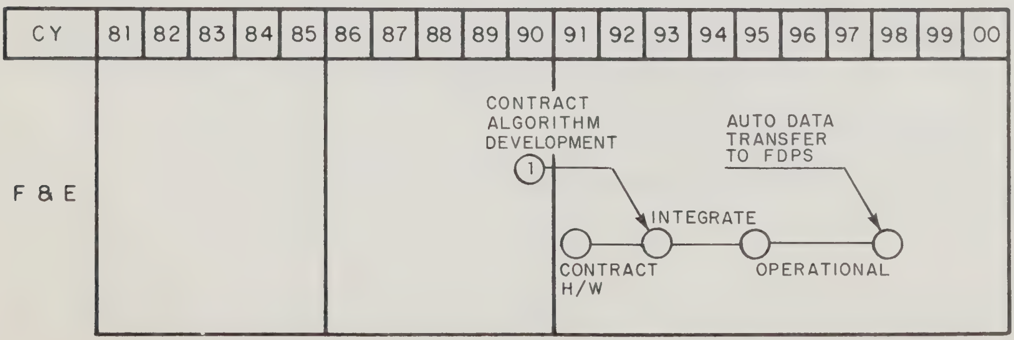


PROJECT: ADVANCED INTEGRATED ATC SYSTEM

PURPOSE: To provide an integrated ATC system which will permit aircraft to fly fuel efficient direct routes and increase system capacity and controller productivity.

In effect, this program will tie together all the ATC systems and through the air-ground data link will allow automatic selection of profiles, automatic detection and resolution alternatives for conflicts, the delineation of restricted areas and hazardous weather and the automatic issuance of clearances to aircraft.

APPROACH: During the mid 90's advanced integration of ATC Systems will begin. Functions will be combined, which together with the Common Controller Workstation (sector suite) will provide the controller with automated aids for preparing and generating fuel-efficient, direct routing clearances. The next phase of integration will free the controller of the responsibility for time critical, moment by moment, detection and resolution of conflicts, as these will be automatically initiated by the system. Finally, the system will be enhanced to automatically plan, generate and deliver conflict free, fuel efficient clearances.

Advanced Integrated ATC System will depend on realizing the implementation of:

- Data link capability (Mode S in radar coverage area, HF or Satellite in northern and oceanic areas) for all aircraft operating above 18000 feet and, in the high density traffic area, down to 12,500 feet.
- Availability of real time upper level wind and hazardous weather data in the central processing complexes of ACCs.
- The Flow Management System, integrated with the central processing complexes.

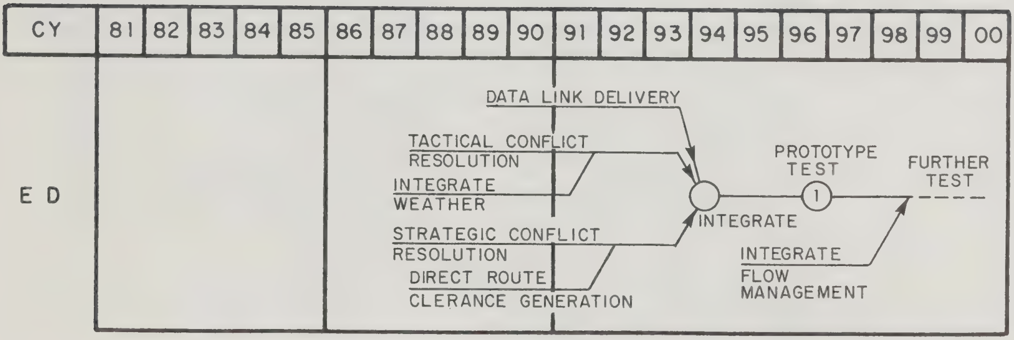
In this environment the role of the controller will gradually change to that of a "system manager".

QUANTITIES: Advanced Integrated ATC System, essentially software, will be installed in all ACCs, and a limited version will be made available for the stand-alone TCU's.

RELATED PROJECTS/ACTIVITIES:

- All Projects and Activities will be involved.

SCHEDULE



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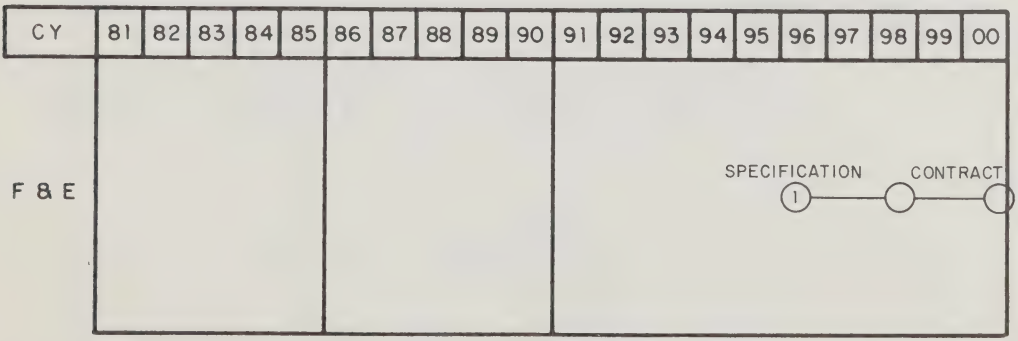


PROJECT: RESEARCH AND EXPERIMENTATION SYSTEM ENHANCEMENTS

PURPOSE: To enhance the capability of the present Research and Experimentation (R&E) system in order to undertake the wider range of studies that will be needed in the future total systems engineering approach to modernization.

As ATS automated systems evolve, considerable use will be made of the R&E Centre to simulate and evaluate the introduction of new ATC functions and to study their impact on the operation. Studies, such as the introduction of conflict resolution, air-ground data transfer, automatic issuance of clearances, which will progressively alter the role of the controller, will have to be throughly proven before they are operationally used.

APPROACH: A continuing schedule of enhancement and expansion is planned beginning with replacement of existing hardware (computer systems and pilot position terminals) capable of operating with existing software. Software conversion to the new mainframe hardware will be effected through a host and rehost process. Early implementation of fast time simulation and additional mathematical modelling capabilities will be introduced. Along with the replacement of hardware, the system will be enhanced to undertake comprehensive human engineering studies that will be required to pace the development of the highly automated ATC systems of the 1990's. Appropriate hardware and software modules will be included to permit the study of wider applications such as Flight Service Station operations, user-friendly weather information access systems, and air-ground data link operations (including dependent surveillance and automatic clearances to aircraft). To enable the investigation of problems in the total integration of Air Navigation Systems, a flight simulator will be added to the R&E Centre.

Software packages developed for the R&E system will be adapted for use in Controller Training and Proficiency Evaluation Simulation Systems.

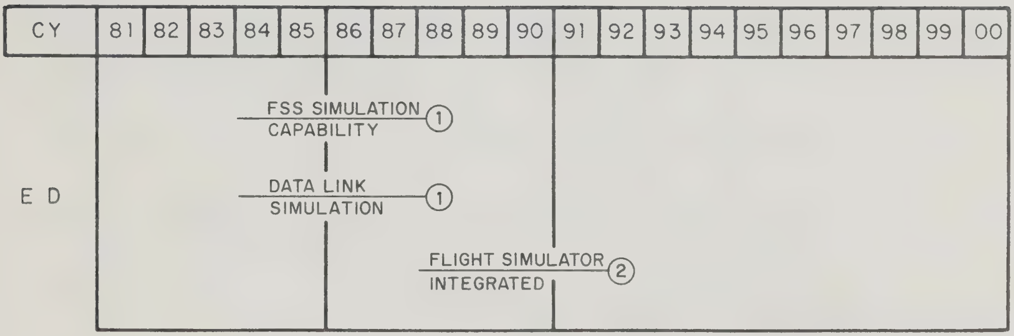
QUANTITIES: Upgrading one R&E System. Fast and real time simulation concepts developed for this system will be appropriately adapted for other systems with similar requirements.

One general purpose flight simulator capable of simulating the performances characteristics of a wide range of aircraft types.

RELATED PROJECTS/ACTIVITIES:

- Controller Training and Proficiency Simulation System,
- Common Controller Workstation,
- Data Link for Dependent Surveillance
- Advanced Integrated ATC System
- FSS Workstation
- Direct Users Access Terminals.

SCHEDULE



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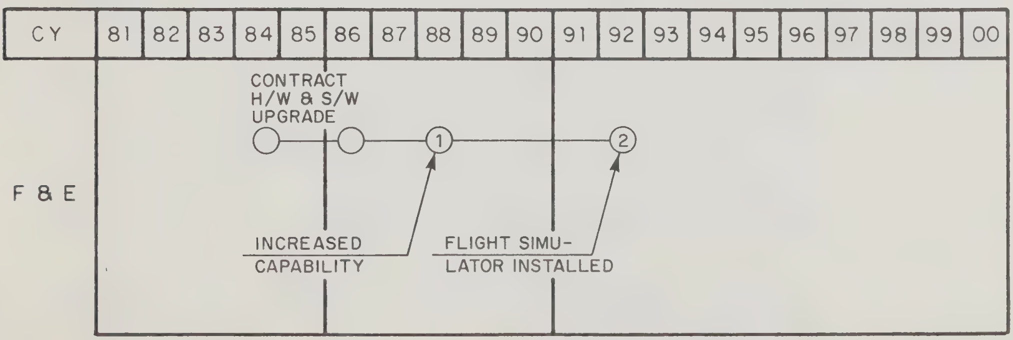


PROJECT: CONTROLLER TRAINING AND PROFICIENCY EVALUATION SIMULATION SYSTEM

PURPOSE: To provide at TCTI, the Regions and at ATC facilities, controller training and proficiency evaluation systems capable of realistically simulating ATC operations environments as these evolve.

As ATC Systems progressively become more automated, and as the role of the controller gradually changes to that of a system manager, it will be necessary periodically to evaluate controller proficiency and those skills required in the event of automation degredation, through the use of realistic simulation. This approach is analogous to methods used for pilot training and proficiency checking.

APPROACH: As more ATC functions are automated, the system will need to be capable of accurately presenting operational scenarios. This will require the provision of suitable controller training and proficiency evaluation simulation systems which will be gradually phased in. Starting at the facility and regional level, replacement of the existing system (Regional Air Traffic Simulators) will be carried out to provide a system representative of ATC operations. These systems will be modelled on developments of the R&E system and will be down-sized but modularly compatible versions of the R&E system. To be determined is the number of regional systems and their location but it is likely that two systems (one in the east and one in the west) will be adequate, with use of the system at TCTI to absorb unusual demands. This approach will enable greater standardization as well as more cost effective utilization of the regional systems.

At the ACC's and TCU's, operational ATC systems will be enhanced to provide "off-line" isolation of controller work-stations (not in use during periods of low traffic activity) to be dedicated for essential job-related training. The on-site training system will be supported by a limited training target generation capability. For more comprehensive exercises (introduction of new operating procedures) linkage between "off-line" workstations and the regional simulator system will be provided.

At TCTI, replacement of hardware and upgrading of the system will parallel the developments of the R&E system. In the domain of ATC Tower simulators studies will be carried out to determine the best cost effective means for such training. Visual training systems for ATC Towers, which are truly representative of the real world, are still being researched, and their potential application for Canada's ATC training will be determined.

Computer Aided Learning will be extensively used in future ATS training systems.

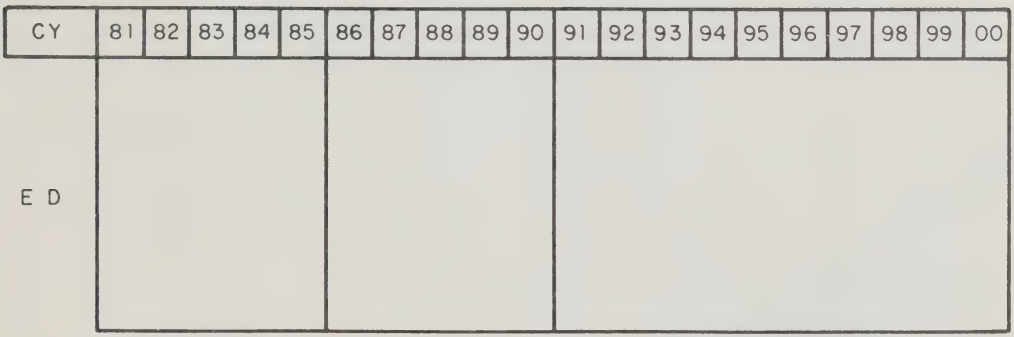
QUANTITIES: Enhancement of systems at ATC facilities to enable "off-line" use of operational systems for controller training and proficiency evaluation.

Probably 2 Regional ATC Training Systems capable of supporting comprehensive multi-sector (controller workstation) ATC training. At TCTI, an advanced training system capable of supporting comprehensive multi-sector (controller workstation) ATC training, based on hardware and software common with and adapted from the R&E system. Visual (ATC Tower) training systems, to be determined.

RELATED PROJECTS/ACTIVITIES:

- R&E System
- Advanced Integrated ATC System
- Computer Aided Learning
- Common Controller Workstation.

SCHEDULE



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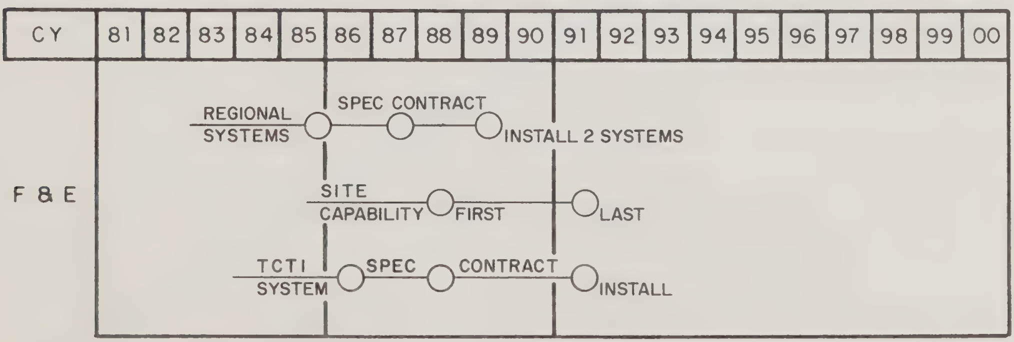


CHAPTER 4

FLIGHT SERVICE SYSTEM

FLIGHT SERVICE SYSTEM

The flight service system encompasses all those services and facilities which provide information and advice to assist the pilot in the planning and conduct of his flight. The provision of such information is a primary responsibility of the Flight Service Station (FSS).

Aeronautical services and information are available to all sectors of the aviation community. Major airlines access certain flight information from source for internal distribution whereas the remainder of the aviation community depend on the Flight Service Station to provide all the required information and services direct to the pilot.

Canada has 116 Flight Service Stations offering a broad range of pre-flight and inflight services.

- Accepting and closing flight plans.
- Briefing pilots.
- Enroute communications with pilots.
- Assisting pilots in distress.
- Disseminating aviation weather information.
- Status monitoring of air navigation radio aids.
- Originating notices to airmen.
- Working with Search and Rescue (SAR) units in locating missing aircraft.

In addition, many stations also:

- Provide VHF direction finder service.
- Observe and collect Weather Data.
- Disseminate aviation weather reports.
- Arrange customs service for transborder flights.
- Provide advisory information to arriving and departing aircraft.
- Provide at airports, positive vehicle advisory.
- Relay ATC clearances and IFR position reports.

The typical FSS is a one-position station located at an airport, operates 24 hours per day and employs 6 Flight Service Specialists. Some stations, because of workload or special requirements, operate two or more positions.

Interfacility data communication is provided by two national fixed telecommunications systems. One is used solely for the transmission and reception of weather data. The other is used for the relay of flight plan data, NOTAM's and related flight plan information. Interphone links between FSS's and air traffic control units enable the immediate exchange of flight data.

Aeronautical information is provided to pilots from the Flight Service Station by pre-recorded and live broadcasts, by telephone or radio contact and person to person briefings. This information is then used, by the pilot, to file a flight plan with the Flight Service Specialist.

The flight plan is then transmitted to the appropriate ATS units. In the event that the flight fails to arrive within the prescribed time, action is initiated to conduct a communications search and alerting information is passed to the appropriate FSS/ACC and Rescue Coordination Centre.

THE NEW APPROACH

Flight services will be improved through modernization and automation. Automated Weather Observing and Reporting Systems (AWORS), to be installed throughout Canada, will automatically collect and forward weather data through a communication system to the central weather computer. The processed aviation weather forecasts and reports will then be forwarded and stored in regional aviation weather processors. Pilots will be able to access this weather information through Direct User Access Terminals (DUATs) or by telephone. These terminals will also be linked to flight planning processors enabling "one-stop" service for all flight planning requirements including the filing of the flight plan itself.

Automation of weather data collection is the key to station consolidation of flight services. By the year 2000 the 116 manned Flight Service Stations will be reduced to approximately 26 Hub stations, each managing several remote unmanned or part-time manned satellite stations through the use of appropriate communications and automation.

Consolidation, along with automation, modernization and innovative methods of disseminating aviation weather information will permit a substantial reduction in FSS personnel. At the same time, automation will ensure that the response and quality of the flight services is vastly improved.

HOW THE SYSTEM WILL EVOLVE

NEAR TERM (TO 1985)

Mass dissemination techniques such as cablevision and commercial radio station broadcast will be employed in high population areas to make pre-flight information, including weather, readily accessible to the aviation community. The availability of this information at a place, time and at a pace most receptive to the pilot will greatly enhance flight planning effectiveness and therefore flight safety.

Automated Weather Observing and Reporting Systems (AWORS) will begin to replace the human observer role at Flight Service Stations. This is a major step in the FSS automation/modernization program which will permit the future consolidation of facilities.

Also, during the near term, the fixed telecommunications network, which ties all manned facilities together, will be upgraded to provide additional capacity at greater speed. This will ensure the timely exchange of all aeronautical information and more current and accurate data banks.

Remote Communication Outlets (RCO's) established at airports will serve as satellite FSS's providing airport advisory and vehicle control services thereby reducing the need for manned facilities. Other RCO's will be established solely to provide enroute pilot communications.

In the near term, automated systems will largely be in the development or early implementation stage. Cost reduction due to automation will be minimal during this period. This stage will initiate the foundation for the implementation of automation techniques during the intermediate and long term.

INTERMEDIATE TERM (TO 1990)

Through automation a number of Flight Service Station Hubs will be established to operate in conjunction with satellite FSS's. These satellite FSS's will be operated with a minimum of on-site maintenance and operations personnel. By 1990 the number of manned FSS will be reduced to approximately 70. VHF direction finder services provided at the satellite's will be remoted to the Hub station.

Initially, the Flight Service Specialist will have information display terminals in order to select (by location, area and flight route), locally stored current aviation weather reports and forecasts to assist pilots with pre-flight planning. A subsequent phase will see FSS work stations and Direct User Access Terminals linked to regional aeronautical information and aviation weather data bases thereby providing all necessary pre-flight information.

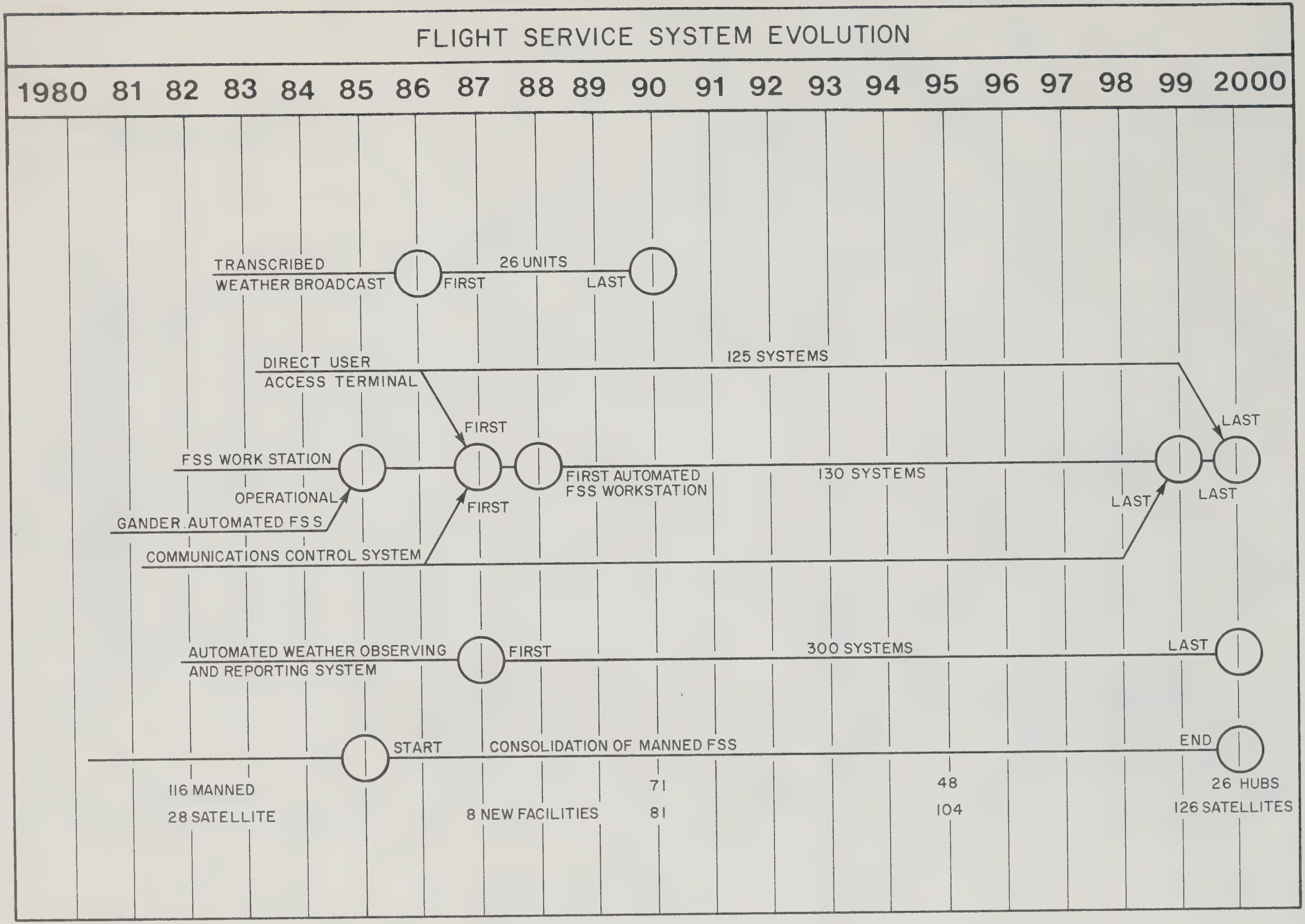
Aviation weather information will also be available by telephone access to computer generated voice response systems linked to regional aviation weather processors. In addition to the normal flight information service, in areas where circumstances warrant, an Enroute Weather Advisory Service (EWAS) will be established on a separate frequency. Calls on this frequency would be responded to by an FSS aviation weather briefing specialist.

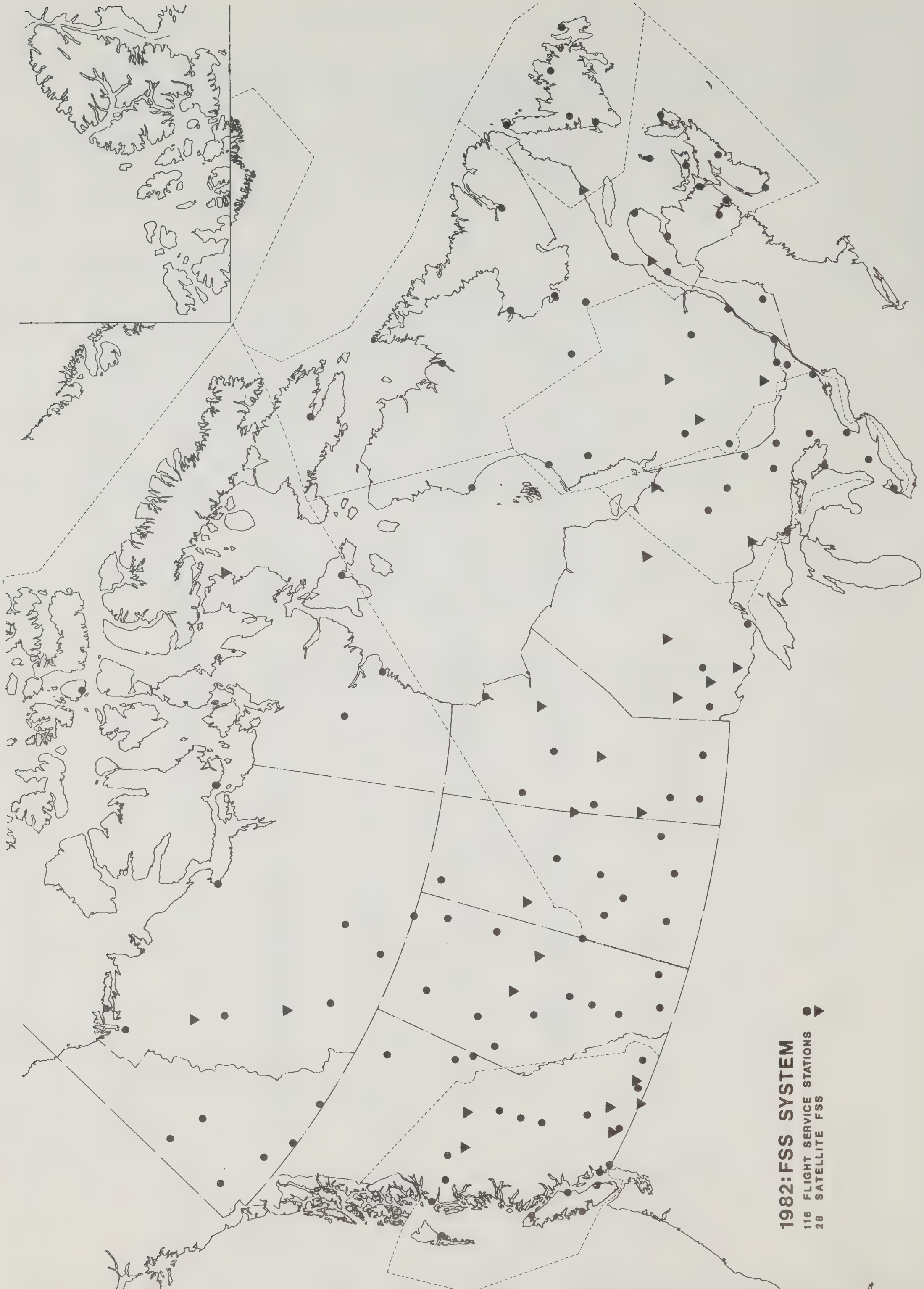
LONG TERM (TO 2000)

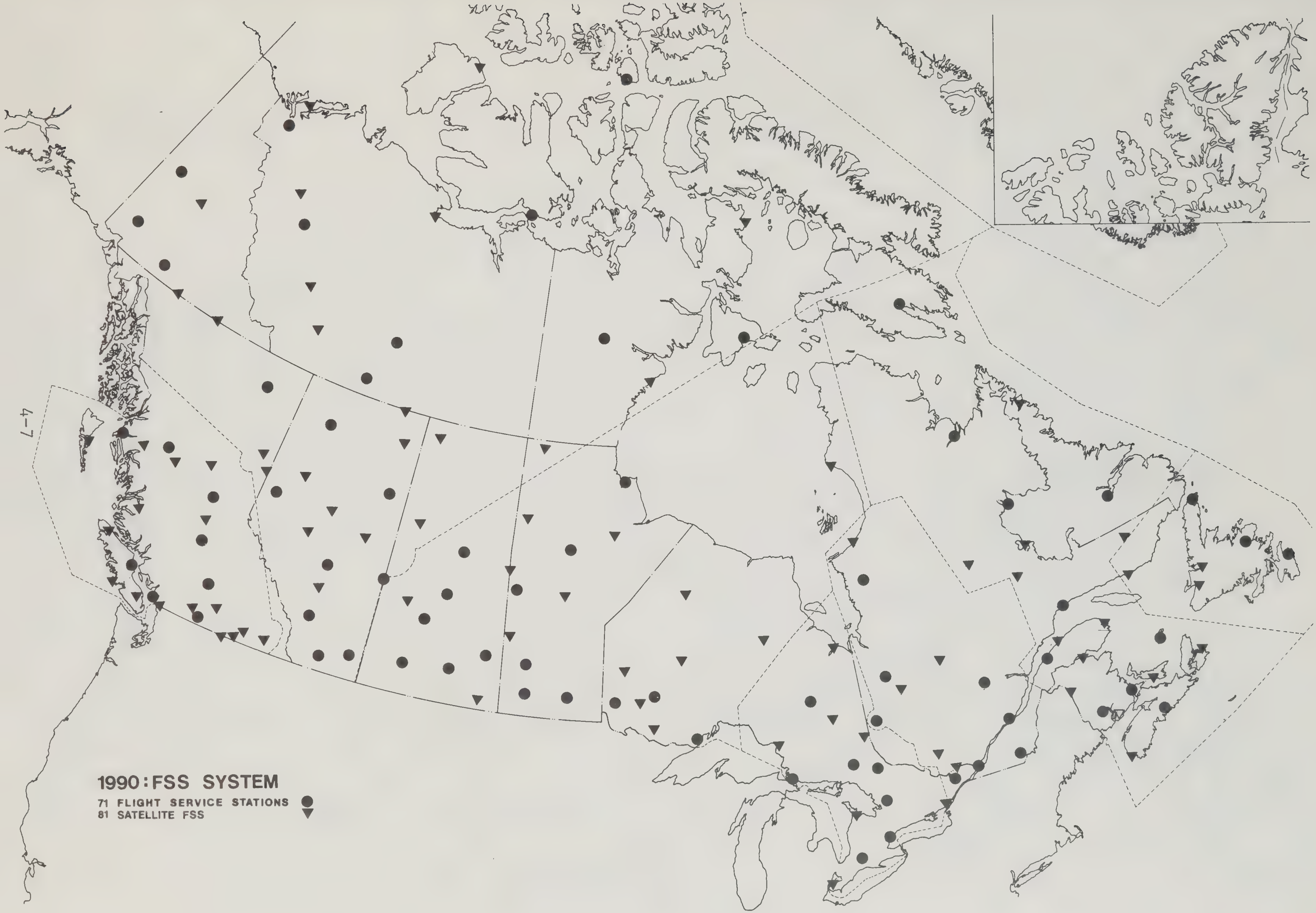
This period will see the full realization of the station Hub concept through extensive use of automated systems. These stations Hubs will provide comprehensive flight services over a wide geographic area. Unmanned and part-time manned satellite FSS's located at airports will be operated through the Hub. The DUAT at the satellite and other flight planning locations (flight dispatch office, pilot lounge, etc.) will now be able to provide all preflight information as well as accept flight plans. Flight plans will be entered directly into the Flight Data Processing System (FDPS) through either the FSS work station or the DUATs. Further dissemination and presentation of the flight plan data will be accomplished automatically by the FDPS.

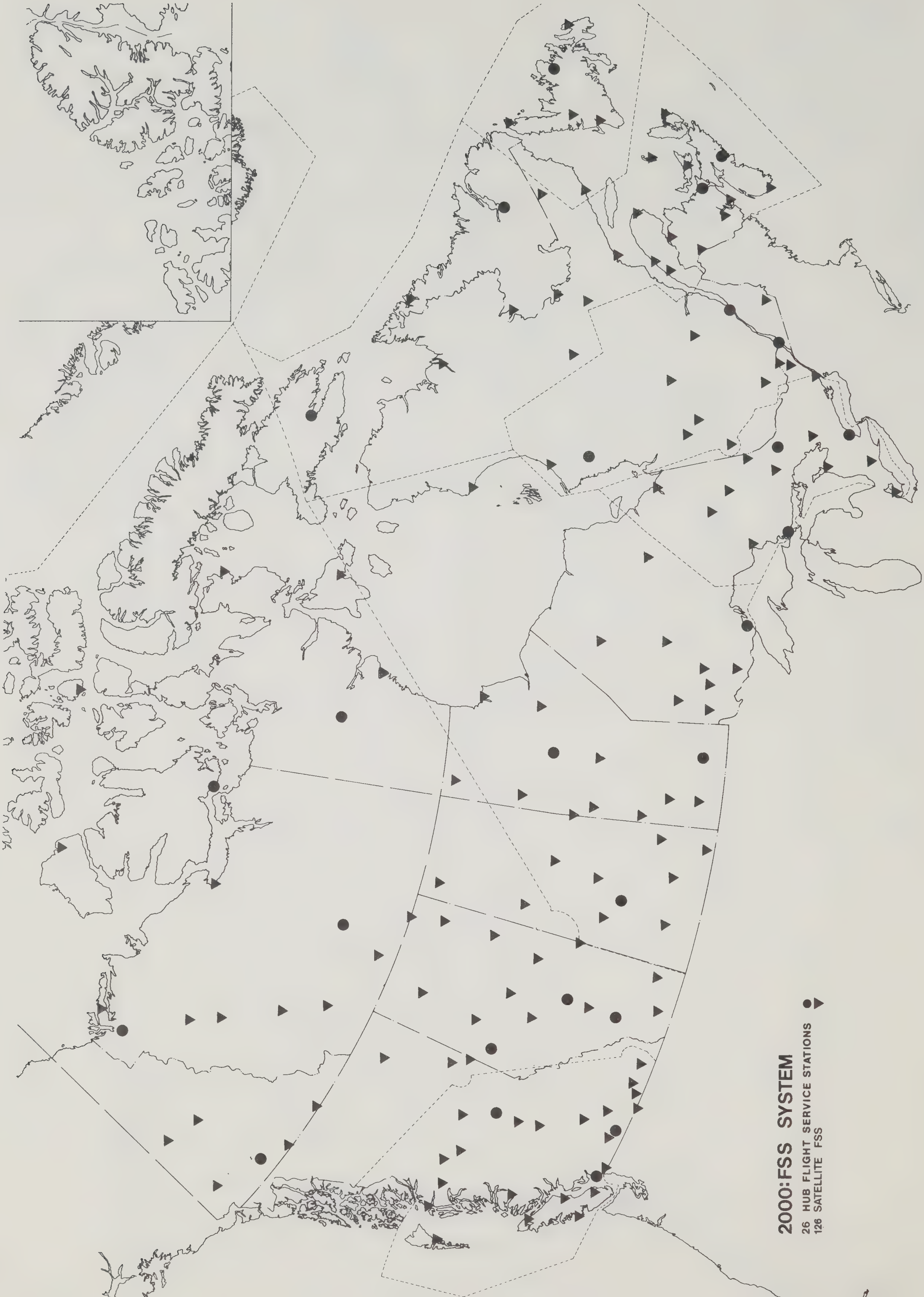
Real time weather data, including radar derived weather information will be graphically displayed at Flight Service Stations and on DUATs. This will improve preflight and enroute briefing services and assist the pilot in avoiding hazardous weather.

By the year 2000, the flight service system will consist of approximately 26 manned multi-position Flight Service Station Hubs with 126 satellite FSS's.


FLIGHT SERVICE SYSTEM EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
TRANSCRIBED WEATHER BROADCAST
FIRST
26 UNITS
LAST
DIRECT USER ACCESS TERMINAL
125 SYSTEMS
FIRST
LAST
FSS WORK STATION
OPERATIONAL
GANDER AUTOMATED FSS
FIRST AUTOMATED FSS WORKSTATION
130 SYSTEMS
COMMUNICATIONS CONTROL SYSTEM
FIRST
LAST
LAST
AUTOMATED WEATHER OBSERVING AND REPORTING SYSTEM
FIRST
300 SYSTEMS
LAST
START
CONSOLIDATION OF MANNED FSS
END
116 MANNED
28 SATELLITE
8 NEW FACILITIES
71
81
48
104
26 HUBS
126 SATELLITES


1982: FSS SYSTEM
116 FLIGHT SERVICE STATIONS ●
28 SATELLITE FSS ▶


1990: FSS SYSTEM
71 FLIGHT SERVICE STATIONS
81 SATELLITE FSS


2000:FSS SYSTEM
26 HUB FLIGHT SERVICE STATIONS
126 SATELLITE FSS

BENEFITS OF THE PLAN

As a result of planned actions, operations costs will be significantly reduced; productivity will increase; and service to the aviation community will keep pace with the forecast growth in demand.

By 1985, in response to the increasing demand for services, the FSS person-years will increase from the 1981 level of 920 to a total of about 1200. As automation systems are implemented commencing in 1987, systems such as AWORS and DUATS will enable consolidation of facilities to begin and person-year requirements to be reduced. By the year 2000, when the full benefits of automation and consolidation are realized, the staff requirements for the FSS activity will be about 20% less than that required in 1981.

PROGRAM	IMPLEMENTATION	
	1st	Last
AUTOMATION		
1. FSS Work Station	1988	2000
2. Direct User Access Terminal	1987	2000
3. Automated Weather Observing and Reporting System	1987	2000
4. Gander Automated FSS	1984	1985
COMMUNICATIONS		
5. Communications Control System (See Chapter 3)	1987	1999
6. Transcribed Weather Broadcast	1986	1990
FACILITY CONSOLIDATION		
7. Consolidation of Manned FSS	1985	2000

PROJECT: FSS WORK STATIONS

PURPOSE: To design FSS communications and briefing positions, taking advantage of state-of-the-art technology and automated systems. The modern automated FSS will require flexible and expandable work stations to meet varying workload and staffing situations. A standard work station design will be developed, significantly increasing Flight Service Specialist productivity. The application of automation within the work station will increase system efficiency, reliability and availability.

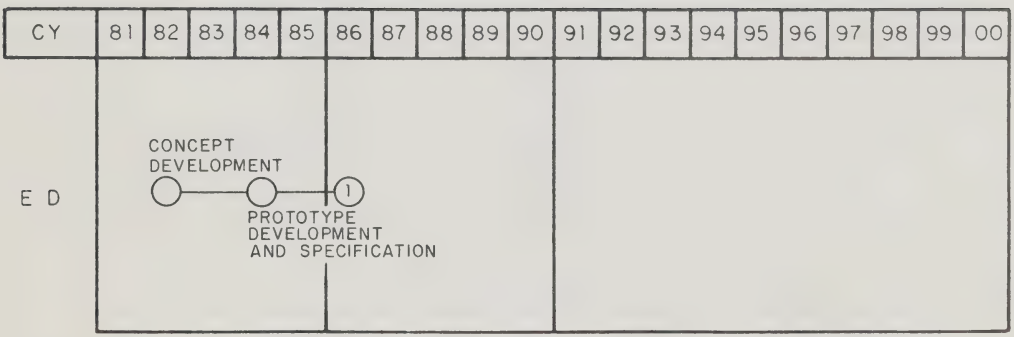
APPROACH: Integrated information and operations control systems will provide the specialist with weather radar and VHF-DF displays, navaid status, current and forecast weather information. Switching of radio frequencies and other voice communications will be accomplished through the Communications Control System (CCS). Work stations will be connected to the flight data processor for reception/input of filed flight plans and to the aeronautical information and aviation weather processor for NOTAM, facility status and aviation weather. The input/output devices such as Video Display Terminals and hard-copy printers will be used. The work station design will allow for modular expansion, both in function and capacity. Engineering development on meteorological information display techniques and intelligent terminals is already underway.

QUANTITIES: 132 work stations will be required for the 26 hubs through the period 1988 to 2000.

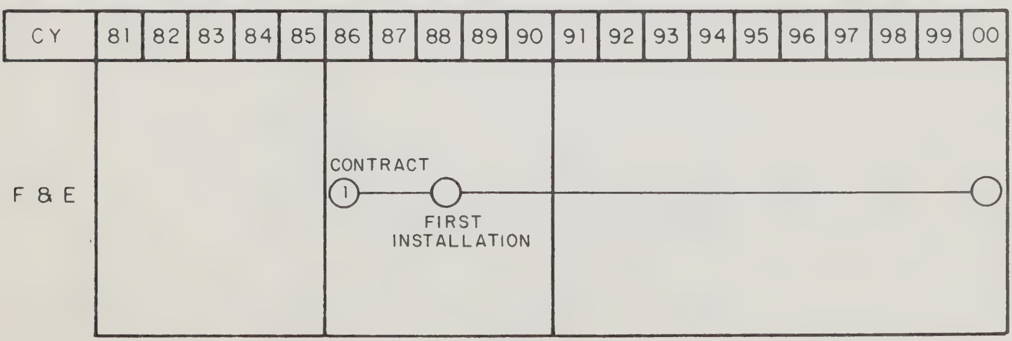
RELATED PROJECTS/ACTIVITIES:

- Communications Control System
- Consolidation of Manned FSS
- Common Controller Work Stations.

SCHEDULE



SCHEDULE



PROJECT: DIRECT USER ACCESS TERMINAL (DUAT)

PURPOSE: To provide users (aircraft operators and pilots) with direct access to preflight information and flight plan filing. The availability of information at a time, place and pace most receptive to the pilot will greatly enhance flight planning effectiveness and permit the more effective and efficient employment of FSS personnel.

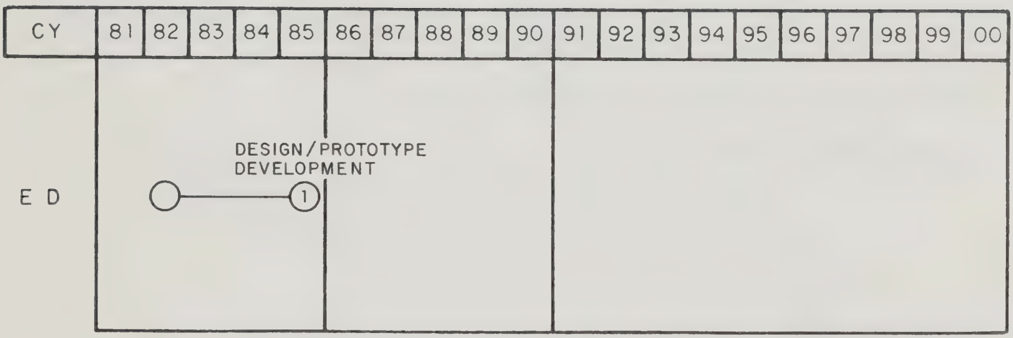
APPROACH: Video display terminals will be provided at satellite FSS's. Interfaces established with aviation weather, flight planning and aeronautical information processors will allow for direct access by these VDT's. Interfaces will also be established to allow for user provided VDT access. Telephone access will also be accommodated.

QUANTITIES: 126 DUAT's will be provided during the period 1985 to 2000 at satellite FSS's.

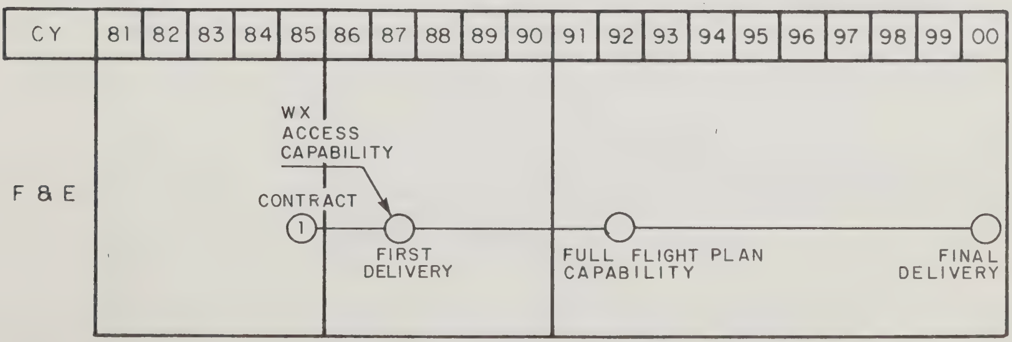
RELATED PROJECTS/ACTIVITIES:

- Consolidation of Manned FSS
- FSS Work Station
- Regional Aviation Weather Processor
- Flight Data Processing System.

SCHEDULE



SCHEDULE



PROJECT: AUTOMATED WEATHER OBSERVING AND REPORTING SYSTEM (AWORS)

PURPOSE: To implement systems which will use automatic weather sensors to provide standard aviation weather observations. These systems will output in 2 Modes:

- Meteorological observations to be fed directly to Regional Aviation Weather Processors and AES Weather Processors.
- In voice form to allow broadcast on navigation and communication facilities.

AWORS will permit establishment of satellite FSS, provide 24 hour weather observing from isolated locations and reduce the weather observing workload of personnel at manned sites.

APPROACH: The order of priority for the establishment of AWORS will be:

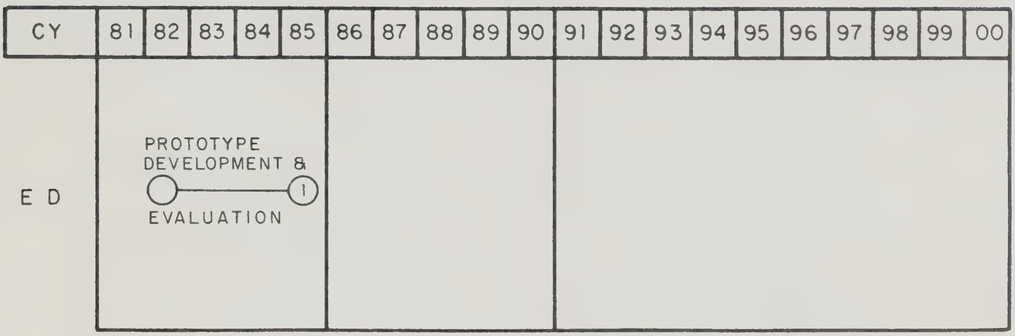
- Locations which provide partial or no weather observations.
- Manned locations, whose replacement will facilitate site consolidation.
- Manned FSS's Hubs which will increase Flight Service Specialist productivity.

QUANTITIES: FSS Facility Requirements - 300 .

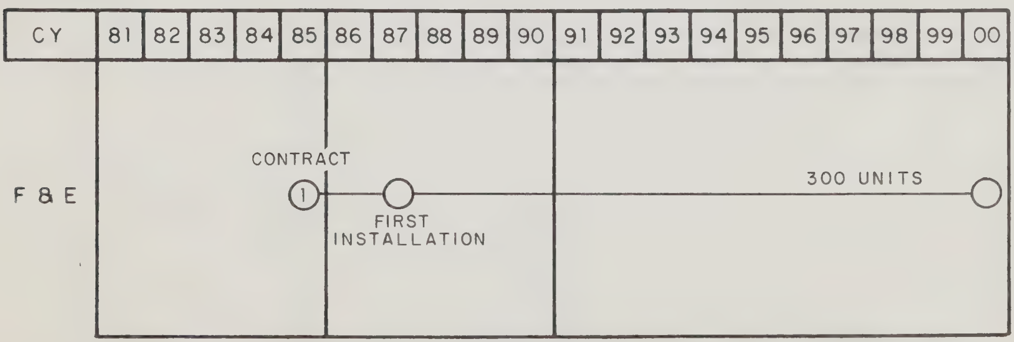
RELATED PROJECTS/ACTIVITIES:

- Primary and Standby Power Systems.

SCHEDULE



SCHEDULE



PROJECT: GANDER AUTOMATED FSS (GAFSS)

PURPOSE: To automate air-ground message formatting so that reports from aircraft will be "computer ready" for processing into ATC automated systems, and to reduce ambient noise level in the operations room.

The Flight Service Station at Gander employs 55 specialists providing air-ground communications with international (North Atlantic and Polar) flights on 4 ICAO assigned HF families of frequencies.

APPROACH: The system will utilize new Video Display Terminals for message formatting and a computer controlled data switch. The GAFSS design will allow for the integration of satellite and HF data link as it evolves.

QUANTITIES: 1 system.

RELATED PROJECTS/ACTIVITIES:

- Gander Automated Air Traffic System
- FSS Workstation
- Communication Control System
- Network Reconfiguration and Integration
- Canadian Aeronautical Digital Network.

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
F & E		SPEC.	CONTRACT		OPERATIONAL															

PROJECT: TRANSCRIBED WEATHER BROADCAST (TWB)

PURPOSE: To provide for the mass dissemination of aviation weather information and other aeronautical information for use at the preflight and inflight stages.

APPROACH: Two types of TWB using the basic Electronic Speech Generator (ESG) units are under development. The first type operates on the principle that the operator inputs a voice message which is digitized, stored and repeatedly broadcast. The message is segmented so it can be selectively updated without complete re-recording. The second type of TWB uses a resident vocabulary to compose a voice message based on input information. This method allows updating of one or more TWB's through direct input from communication networks. TWB's are accessible by telephone as well as by reception on the selected broadcast facility.

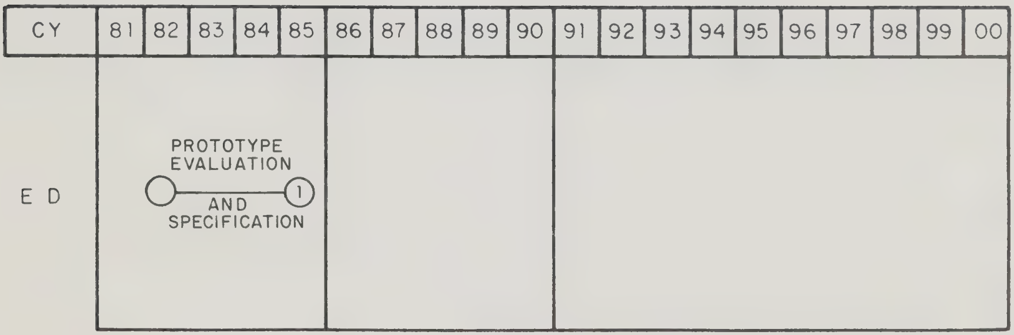
A prototype system is being presently evaluated . Future systems will be based on the results of this evaluation.

QUANTITIES: 26 Units will be situated with FSS Hubs during the period 1986 - 1990.

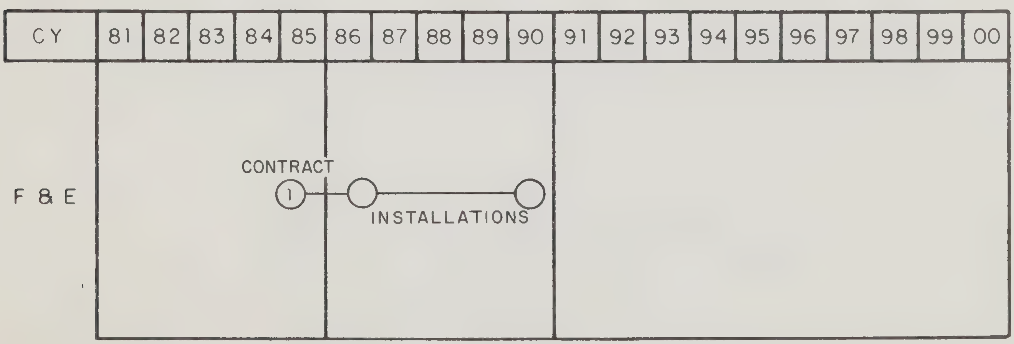
RELATED PROJECTS/ACTIVITIES:

- Automated Weather Observing and Reporting System.

SCHEDULE



SCHEDULE



PROJECT: CONSOLIDATION OF MANNED FSS

PURPOSE: To improve operational productivity and cost effectiveness by reducing the number of manned facilities and utilizing automated systems in lieu. The use of automated systems such as AWORS, RCO's and DUAT's will permit the operation of unmanned satellite FSS, while improving service levels. Staff will thus be more effectively employed at FSS Hubs as automation is deployed.

APPROACH: Progressively, Flight Service Stations at airports with low traffic operations will be replaced by satellite FSS. The Hub stations will provide central control and operational support for UNICOMS, community airport radio stations, remote communications outlets and satellite Flight Service Stations.

As FSS Hubs are implemented the necessary buildings and associated facilities will require replacement, refurbishing or upgrading as required.

QUANTITIES: Consolidate to 71 locations by 1990, 48 by 1995 and 26 by 2000.

RELATED PROJECTS/ACTIVITIES:

- Automated Weather Observing and Reporting Stations
- Direct User Access Terminal
- FSS Work Station.

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
F & E					BEGIN			CONSOLIDATION OF MANNED FSS		71 HUBS					48 HUBS				26 HUBS	

CHAPTER 5

AVIATION WEATHER SYSTEM

AVIATION WEATHER SYSTEM

The Federal Government agency responsible for providing meteorological services is the Atmospheric Environment Service (AES) of Environment Canada. The Canadian Air Transportation Administration (CATA) is responsible for the level of service including: dissemination of aviation weather, identification of the location of aviation weather offices, and the provision of resources. This aviation weather service is provided through several agencies including: AES, CATA's Flight Service Stations (FSS), Arctic Aviation Weather Reporting Stations (AAWRS), Contract Aviation Weather Stations (CAWS) and Private Aviation Weather Reporting Stations (PAWRS). AES offices located at airports may provide aviation weather briefings, but the prime disseminators of weather information to aircraft operators are the FSS specialists. AAWRS and PAWRS personnel are trained and periodically evaluated by AES. CATA identifies the operational requirements and provides funding for the AAWRS, but the personnel manning is a responsibility of the Territorial government. PAWRS must meet CATA specifications for approval. They are funded and manned by non-federal sources to satisfy localized aviation requirements, except in special cases, where a specified level of service is provided, some federal assistance and funding will be provided.

There are approximately 300 locations throughout Canada that take weather observations. Less than half provide hourly weather reports 24 hours per day. The remainder provide from as many as 18 to as few as 4 observations per day. Some isolated sites provide observations only on demand. Therefore, the detailed aviation forecasts that are issued four times per day are prepared, at times, from information derived from observations taken from less than 50% of all the locations.

An excellent source of aviation weather data are pilot reports (PIREPS) provided by aircrew involved in daily flying operations. These timely reports are normally relayed to ATS facilities and if disseminated serve as an excellent source of information on weather phenomena that cannot be viewed or experienced from the ground. (example: cloud tops, cloud layers, turbulence, freezing precipitation layers, ceilings, visibilities, etc.) PIREPS are not used by AES in preparation of aviation weather forecasts or reports to the extent they could be; nor does their creation receive adequate priority by aviators.

Weather information is collected manually except for some limited data provided by approximately 60 AES automatic devices located across Canada. This information is transmitted to the AES weather computer (Toronto) which distributes it to appropriate ATC, FSS and other agencies. The computer also analyses and processes it into basic weather forecast information before being retransmitted to area weather offices located across Canada. The aviation weather forecasts are then prepared in the area offices and subsequently disseminated to various subscribers including ATC facilities, FSS, AAWRS, PAWRS, CAWS and commercial operators. In addition satellite and AES weather radar data contribute significant information for aviation weather forecasts while CATA radars provide real time imagery of existing weather conditions.

Pilots acquire weather information from the various agencies primarily by phone or by personal contact. Additional information is available while airborne or on the ground through Transcribed Weather Broadcasts (TWBs), air-ground radios, commercial TV and radio weather programs, Automatic Terminal Information Service (ATIS), and various other auxiliary systems. In areas where there is a high volume of air traffic, dissemination of aviation weather to the pilot is a major problem as phones are generally busy and most public weather reports on radio and TV are not of the quality required for aviation.

THE NEW APPROACH

Aviation weather service will be improved in quality and timeliness through automation. 300 observation sites will be fitted with Automated Weather Observing and Reporting Systems (AWORS) that will transmit pertinent aviation weather data to the central AES computer through CATA aviation weather processors. Mass means of dissemination of aviation weather will be introduced. Dedicated video display terminals with key board access to aviation weather data banks will employ computer derived graphical displays to present weather in an easily interpretable format. Access to this "real time" weather information will be streamlined. Air Traffic Controllers and Flight Service Specialists will use automated display terminals to access aviation weather processors for pertinent information including the display of weather radar data. Eventually Direct User Access Terminals (DUATs) will be appropriately located to provide one stop flight planning service. The pilot's action of entering his intended flight profile into a DUAT will trigger the display of pertinent weather and enroute flight information. When satisfied that all flight planning options are resolved, the pilot will action the terminal to transmit the flight plan to the Flight Data Processing System (FDPS). Modern TWBs will have aviation weather data digitally stored. This information will be continuously transmitted over navigational aids or VHF by an electronic speech generator, or on demand by telephone. The user may either dial specific aviation weather sequences pertaining to his planned flight, or call up the full aviation weather briefing stored on a particular TWB.

Ease of access to real time accurate weather information will assist pilots in avoiding hazardous flight conditions. Weather information will be available in the aircraft on hard copy or display readout through data link. Increased accuracy of aviation weather forecasts will encourage pilots to navigate using minimum time tracks resulting in appreciable fuel savings. Some aircraft will relay, through data link, upper air wind vectors and other pertinent information to the ground system.

An evaluation will be conducted at various Canadian airports to determine if a Low Level Wind Shear Alert System (LLWSAS) has value in warning pilots on approach or departure of potentially hazardous flight conditions.

New weather processors will provide wind vectors for input to the air traffic control computers. This will facilitate the application of strategic control by providing early resolution of traffic conflictions through the calculation of minor deviation options for the involved flight planned or enroute aircraft. Avoidance of hazardous weather detected by radar will be similarly resolved. In the high density traffic areas a combination of AES, DND and TC radars will provide effective weather radar coverage at the lower altitudes and volumetric coverage at 18,000 feet and above. The weather detection capability of the new RAMP radars together with real time weather radar data from AES and DND will provide controllers with improved weather radar data essential for automated metering and sequencing of air traffic in busy terminal control areas. The flight service specialists work stations will also have access to this radar data to provide pre-flight and inflight weather advisory service to pilots.

HOW THE SYSTEM WILL EVOLVE

NEAR TERM (TO 1985)

In the near term further progress in mass dissemination of aviation weather information through use of commercial TV and radio will reduce the demand for individual briefings. Either commercial cable channels or dedicated visual display terminals with access to weather data computers will display weather graphically in an easily interpreted format. Continued emphasis on completing the training of Flight Service Specialists as aviation weather briefers as well as improving communication links to all weather offices will increase the volume of aviation weather presentations. TWBs will be modified to store aviation weather broadcasts digitally and provide the pilot with the option to phone for specific weather sequences.

Evaluation of Low Level Wind Shear Alert System (LLWSAS) will commence at major airports. Research on wake vortex warning devices, currently ongoing in the United States, will be pursued by CATA.

INTERMEDIATE TERM (TO 1990)

Major improvements in weather service will occur during the period 1985-1990. Automation of weather observation and dissemination will commence with the installation of AWORS. The weather data from these automated observing devices will be transmitted to the central AES weather computer by a data network. Resultant aviation forecasts will be prepared from an increasing data base and real time weather reports will become accessible.

Air traffic services personnel and aircraft operators will be able, through automation, to access automated aviation weather data for information pertinent to flight. During enroute flight, pilots will be able to acquire aviation weather from TWBs, AWORS or through use of the dedicated FSS Enroute Weather Advisory Service (EWAS). The dedicated VHF channel will also serve to improve the exchange and dissemination of pilot weather reports (PIREPS). The installation of primary surveillance radar at TCUs plus the provision of AES weather radar data will enable ATS personnel to accurately identify areas of hazardous weather.

To enhance safety, LLWSAS will be installed at airports where evaluation has determined an operational requirement.

LONG TERM (TO 2000)

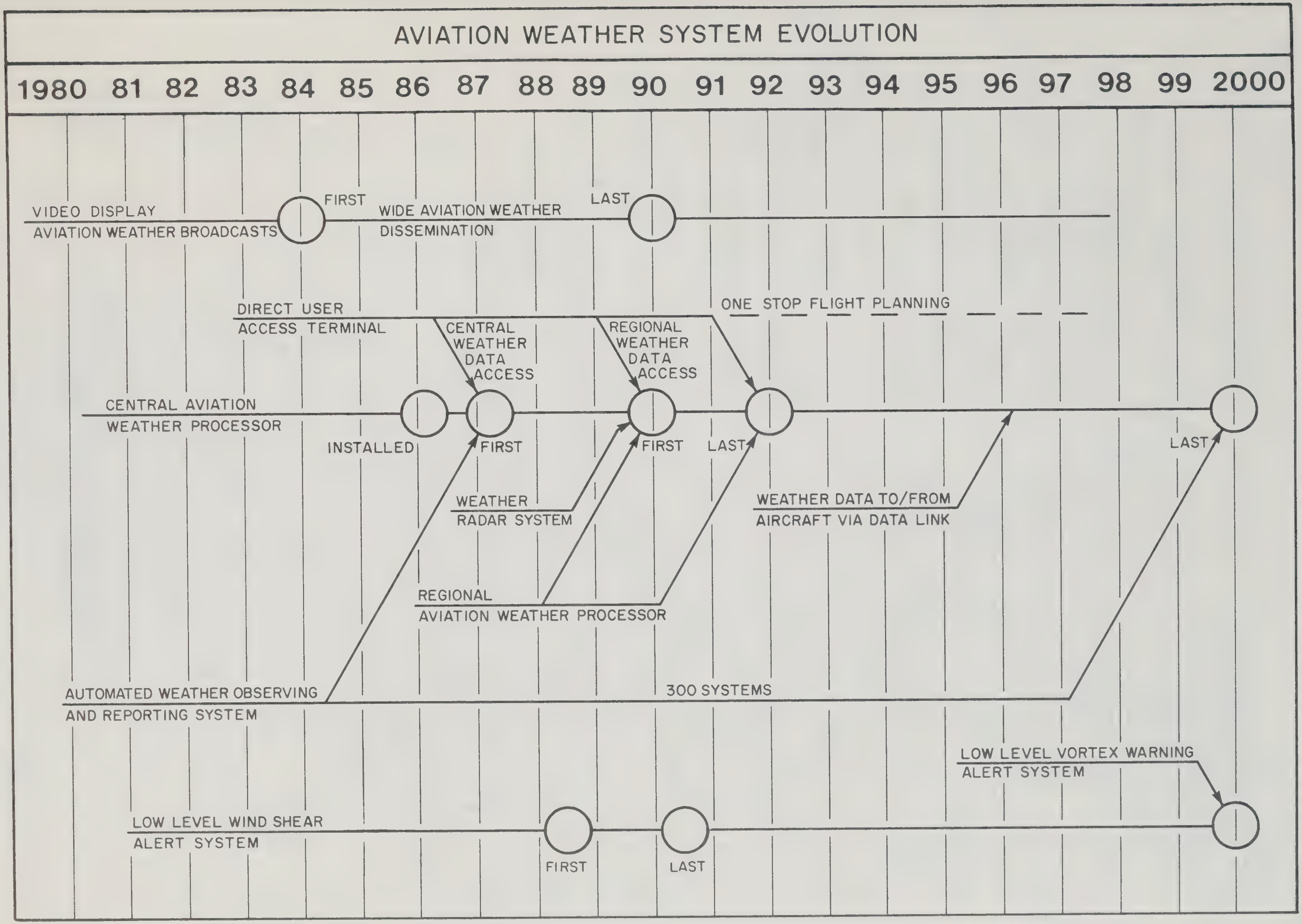
As more AWORS are installed across Canada, the number of weather observations will increase considerably. The additional data will improve the quality and accuracy of aviation weather forecasts. Automatic airborne meteorological sensors installed on selected aircraft will communicate, on demand, high level weather phenomena to regional aviation weather processors through data link.

Dissemination of aviation weather forecasts and reports to air traffic facilities and aircraft operating agencies will be through CATA's regional aviation weather processors. This aviation weather will be obtained from a central CATA aviation weather processer which will access the AES weather computer for the aviation forecasts.

Mass dissemination of aviation weather will continue to be improved through use of appropriate public communication media. More detailed and specific weather information will be provided through DUATs located at flight service stations, flying schools and private or corporate aviation operation centers. Limited two way communications with the regional aviation weather processor will also be available simply by the proper keying of a touch-tone telephone. The processor will respond with the requested aviation weather information through electronic speech generation.

During enroute flight, pilots will be able to acquire real time weather reports from an increasing number of AWORS and TWBs equipped with electronic speech generators. Aviation weather information will also be available to aircraft through data link. A dedicated VHF channel will remain available for pilots to communicate directly with the aviation briefing specialist.

Depending upon research and development, wake vortex turbulence warning sensors will be installed at qualifying airports by the year 2000.


AVIATION WEATHER SYSTEM EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
VIDEO DISPLAY
AVIATION WEATHER BROADCASTS
FIRST
WIDE AVIATION WEATHER
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CENTRAL WEATHER DATA ACCESS
REGIONAL WEATHER DATA ACCESS
ONE STOP FLIGHT PLANNING
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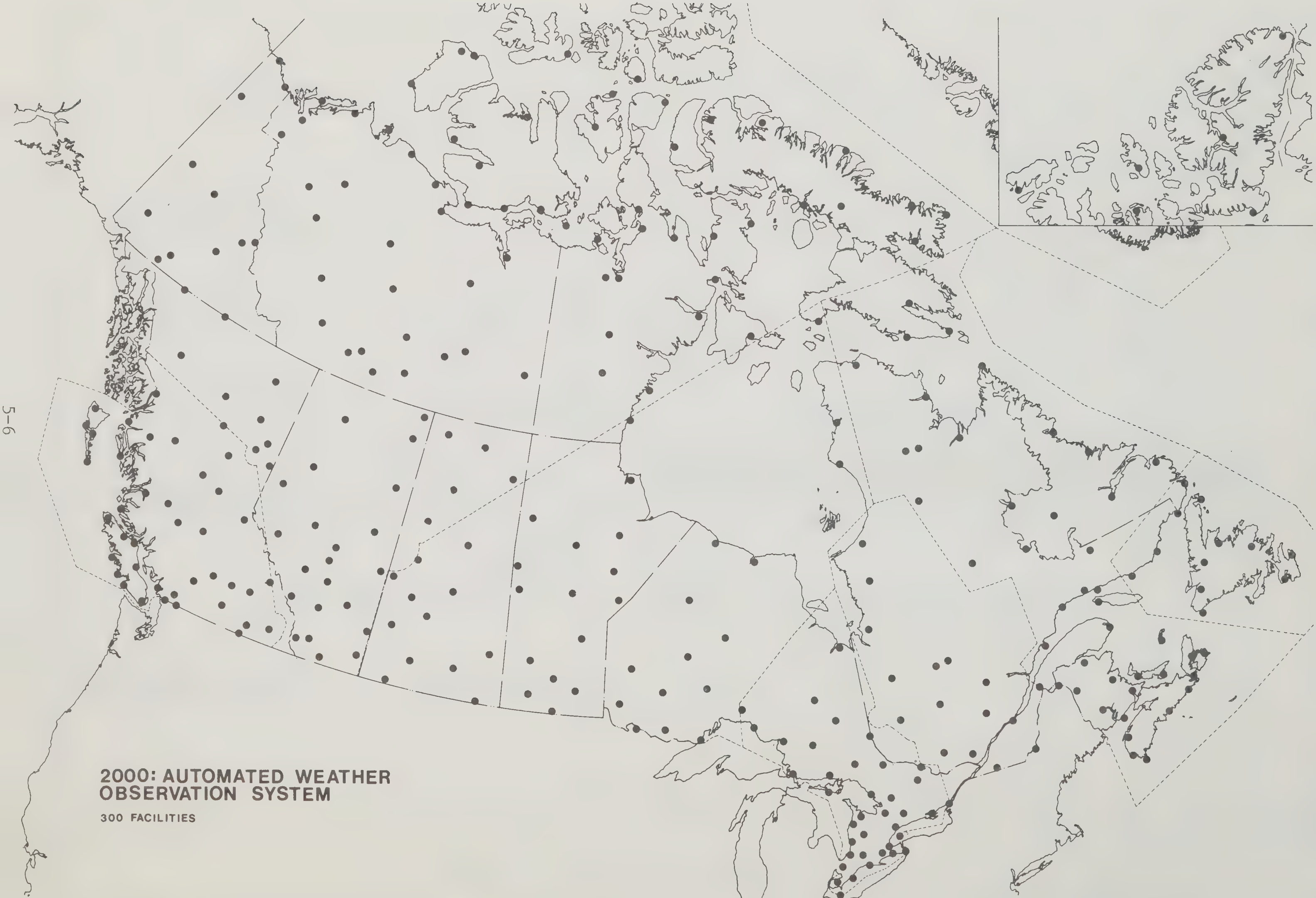
300 SYSTEMS
LOW LEVEL VORTEX WARNING
ALERT SYSTEM
LOW LEVEL WIND SHEAR
ALERT SYSTEM
FIRST
LAST


2000: AUTOMATED WEATHER
OBSERVATION SYSTEM
300 FACILITIES

PROGRAM	IMPLEMENTATION	
	1st	Last
AUTOMATION		
1. Central Aviation Weather Processor	1986	
2. Regional Aviation Weather Processor	1990	1992
3. DUAT (see Chapter 4)	1987	2000
MASS WEATHER DISSEMINATION		
4. Video Display Aviation Weather Broadcasts	1984	1990
SENSORS		
5. AWORS (See Chapter 4)	1987	2000
6. Weather Radar System (See Chapter 6)	1990	
7. LLWSAS	1988	1990
8. LLVWAS	2000	

PROJECT: CENTRAL AVIATION WEATHER PROCESSOR

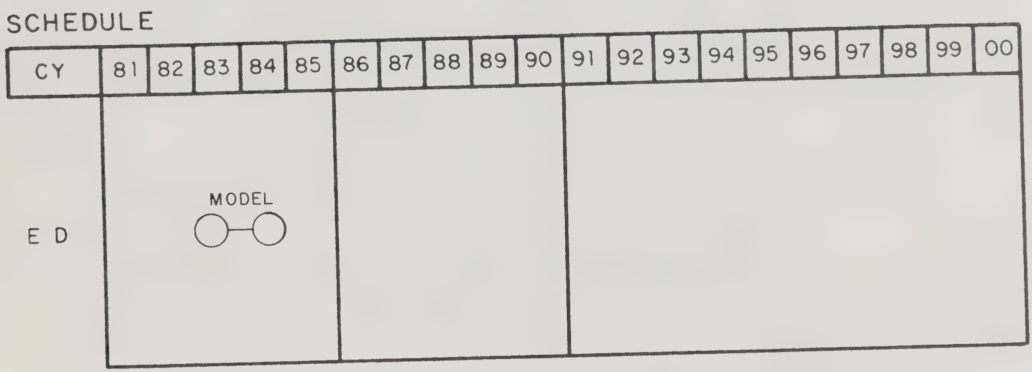
PURPOSE: To provide a national aviation weather data base for direct transfer of weather information to and from the Regional Aviation Weather Processors and to provide the link between CATA and AES for all weather information transfer. Improved availability of weather information will lead to reductions in weather related accidents and weather related air traffic delays.

APPROACH: The Central Aviation Weather Processor will be developed as a data base management system capable of accepting the current weather observations. The aviation weather forecasts will be obtained from the AES computer. Relevant weather information for each FIR will be transferred to the Regional Aviation Weather Processors. Transfer of the data will be initially by ADIS and subsequently by CADIN.

QUANTITIES: There will be one system.

RELATED PROJECTS/ACTIVITIES:

- Regional Aviation Weather Processor
- AWORS
- Weather Radar System
- Direct User Access Terminal.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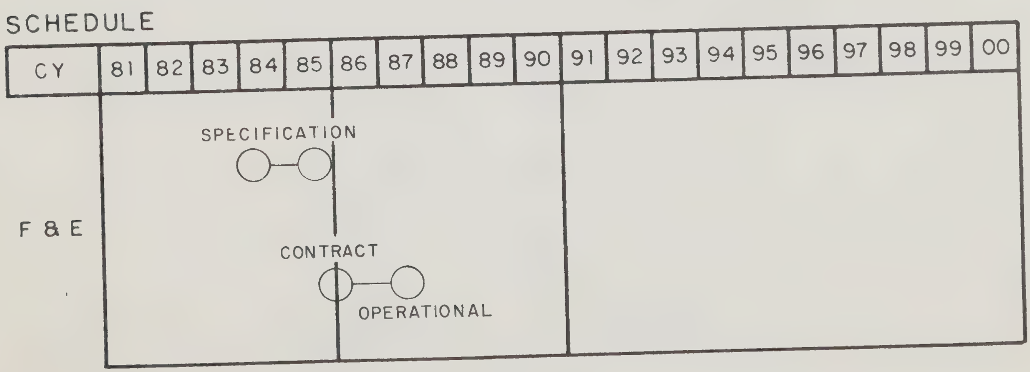
SCHEDULE
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F & E
SPECIFICATION
CONTRACT
OPERATIONAL

PROJECT: REGIONAL AVIATION WEATHER PROCESSOR

PURPOSE: To provide real time dissemination of weather information for air traffic controllers, flight service specialists and DUATS. To provide the weather data base for direct transfer of weather information via data link to aircraft in flight. To provide accurate wind vector profiles for meteorological models used for strategic flight time estimates, conflict prediction and resolution.

Improved availability of weather information for pilots, ATC and FSS personnel will lead to reductions in the large number of weather-related accidents and in air traffic delays caused by weather.

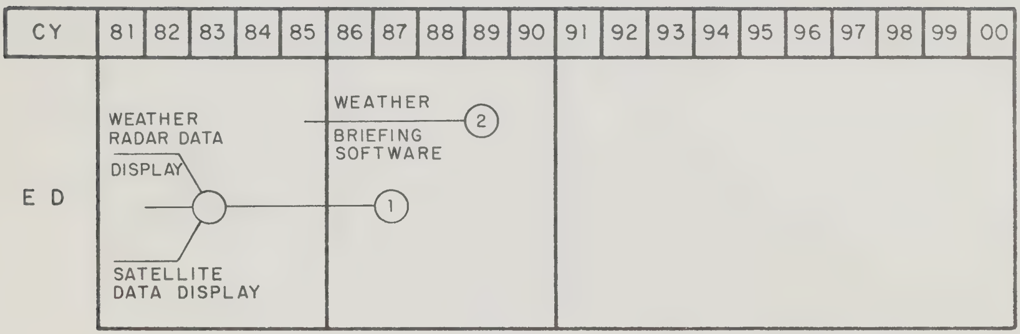
APPROACH: The Regional Aviation Weather Processor will be developed in an evolutionary manner. Initially it will provide ATC and FSS personnel with weather observation and forecast data plus real time radar-derived weather information. With the addition of specialized weather briefing software, direct pilot access to pertinent weather data for flight planning purposes will be provided. Later, with the implementation of air-ground data link capabilities, the weather data will also be available in flight. Sources of weather data will include AWORS, weather radars, meteorological satellites, AES reports and forecasts. Outputs will include relevant data for flight planning, hazardous weather information and automated updates for weather models.

QUANTITIES: Systems will be provided for each of the ACCs, one to TCTI and one to the Technical System Centre.

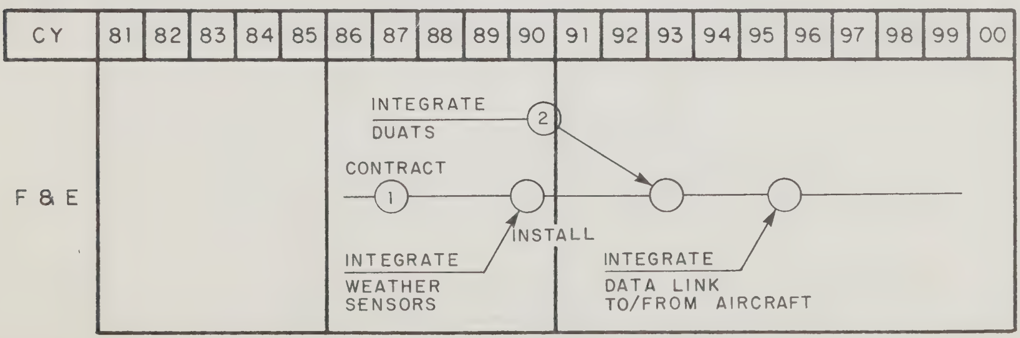
RELATED PROJECTS/ACTIVITIES:

- AWORS
- Weather Radar Data Network
- Direct User Access Terminal
- Central Aviation Weather Data Base.

SCHEDULE



SCHEDULE



PROJECT: VIDEO DISPLAY AVIATION WEATHER BROADCASTS

PURPOSE: To enable wide dissemination of aviation weather in areas where there is concentrated private and general aviation flight training and operations. To ensure pilots receive adequate and timely knowledge of weather conditions.

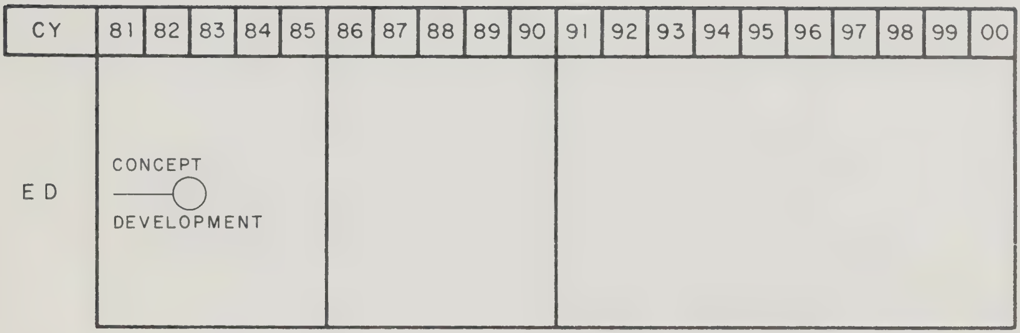
APPROACH: Dedicated video display terminals designed to gain access to an aviation weather data base will provide latest area and terminal aviation weather information. This system will include computer derived easily interpretable graphical displays including vertical and horizontal profiles of specific routes and the local area. Radar derived data will be used to display location and severity of precipitation and thunderstorms.

QUANTITIES: Initially eight locations across Canada.

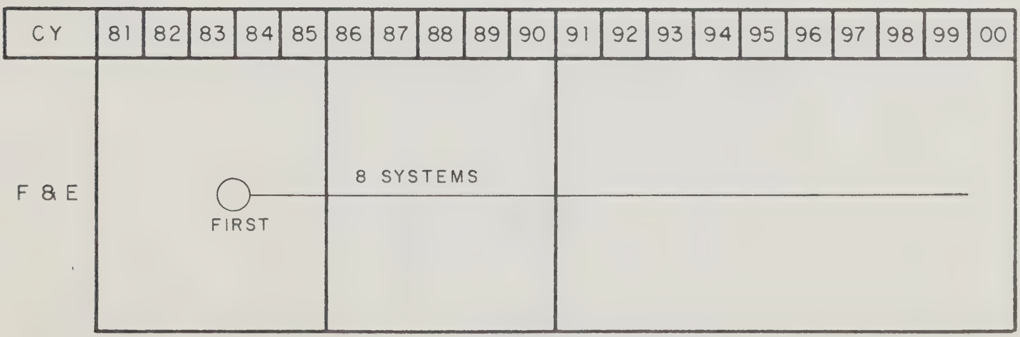
RELATED PROJECTS/ACTIVITIES:

- DUATS.

SCHEDULE



SCHEDULE



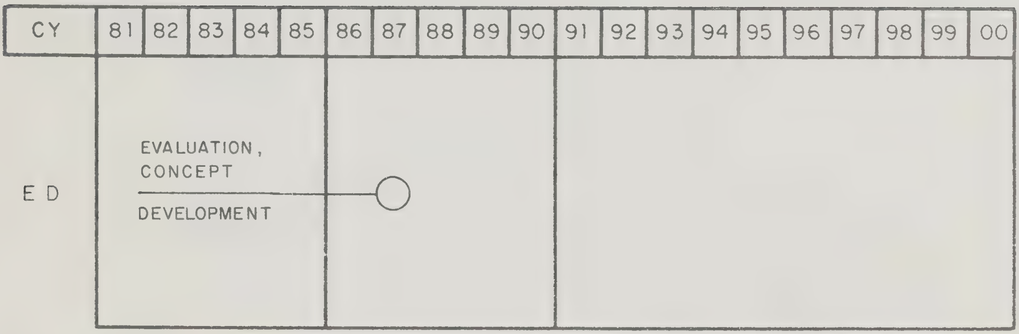
PROJECT: LOW LEVEL WIND SHEAR ALERT SYSTEM

PURPOSE: To alert the pilot, through the local tower controller, of the probability of hazardous wind shear on final approach. Certain airports are more severely affected by frontal and thunderstorm activity that generate wind shears with extreme velocities. Installation of a wind shear alerting system will ensure pilots are alerted to this hazard.

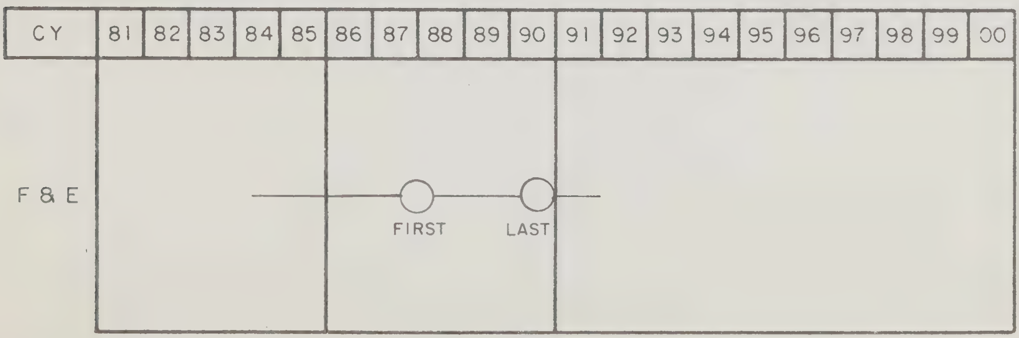
APPROACH: Information from ideally sited wind measurement devices connected through processors will detect and alert controllers to wind shears.

QUANTITIES: As required.

SCHEDULE



SCHEDULE



PROJECT: LOW LEVEL VORTEX WARNING ALERT SYSTEM

PURPOSE: To detect the presence of wake vortices and provide this information to controllers in order that the larger longitudinal separations required when light aircraft follow heavy jet aircraft need be applied only when necessary, thereby optimizing runway capacity. Safe separation is predicated on decay or dispersion of vortices, therefore the installation of an LLVWAS will detect the presence of a vortex and aid the controller in determining safe but optimal separations for aircraft on approach or takeoff.

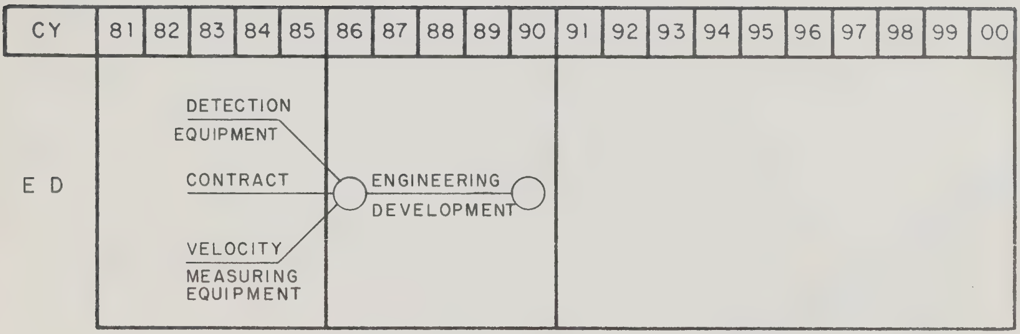
APPROACH: Engineering development will be undertaken to design and test feasibility of wake vortex measurement and prediction. Current work in the United States will be monitored closely and joint development considered to adapt measurement techniques to Canadian environment.

QUANTITIES: To be determined.

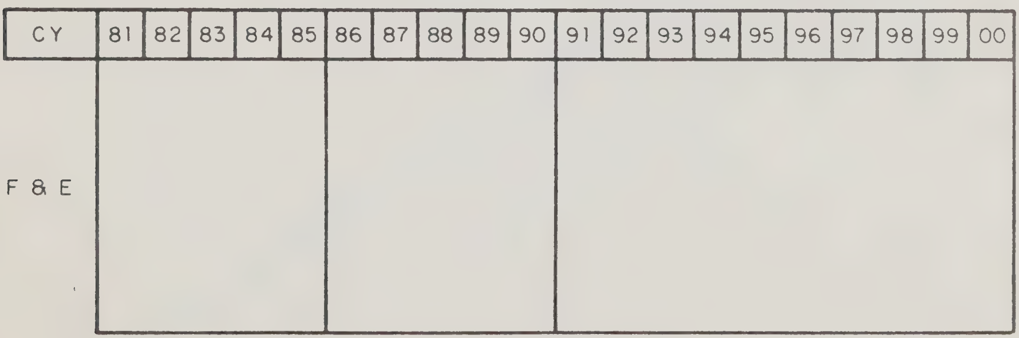
RELATED PROJECTS/ACTIVITIES:

- Low Level Wind Shear Alert System.

SCHEDULE



SCHEDULE



CHAPTER 6

GROUND TO AIR SYSTEM

GROUND TO AIR SYSTEM

The ground-to-air system comprises navigation, surveillance and communication systems. Navigation systems provide guidance to aircraft while surveillance systems provide aircraft position information to air traffic controllers at ACC's, TCU's and Towers. Communication systems provide radio links between pilots and air traffic controllers or flight service specialists.

NAVIGATION

The navigation systems can be broadly divided between those which provide enroute guidance and those which provide approach and landing guidance although some are used for both purposes if they are suitably located.

The present route structure for the navigation of air traffic is based both on navigation and air traffic control requirements and is characterized by the strategic placement of VHF Omni-Ranges (VOR) and/or Non-Directional Beacons (NDB) for the delineation of airways (controlled airspace) and air routes (uncontrolled airspace). The VOR may be co-located with either Distance Measuring Equipment (DME) or military Tactical Air Navigation System (TACAN). Azimuth guidance is provided by the VOR whilst distance to the VOR is provided by either the DME or the TACAN. NDB's utilized in the enroute system are of high power (above 100 watts).

The main disadvantage of the airway and air route method of navigation, at least for the longer range flights, is the lack of flexibility in routing. Some aircraft, equipped with area navigation systems, are capable of navigating on any desired track within the coverage of station-referenced navigation aids or within the limits of a self contained navigation system. This allows more direct and fuel-efficient routing through the system, which is limited at present by the requirements of the ATC system.

Long range ground based navigational systems such as Omega and Loran C are not currently considered as an integral part of the present system. They are, however, becoming more widely used in areas where coverage is available and for special applications.

The present airport approach and landing systems can be divided into two categories; non-precision and precision. The non-precision system is comprised of low power NDB's, VOR's and stand-alone localizers (LOC) which in some cases are supplemented with DME (LOC/DME). The precision system consists of the ICAO standard Instrument Landing System (ILS). The precision system uses both elevation and azimuth guidance from the ground facility as well as marker beacons and locator NDB's and in some cases DME. The non-precision approach uses only azimuth guidance and as a result such approaches permit landings only under higher weather minima than the precision system.

Of the present enroute and approach and landing navigation equipment, only 50% has been upgraded to solid state technology. Remote maintenance monitoring such as might be achieved by microprocessor control is not currently a feature.

The VHF Direction Finder (VHF/DF) is used to guide pilots who are lost or uncertain of their position and for other emergencies. The aircraft's bearing is determined from the ground station using the aircraft's radio transmissions and used by ATC and FSS to provide verbal guidance to the pilot. All of the present VHF-DF equipment is solid state.

The Runway Visual Range (RVR) is a computed visibility value representing the minimum expected distance a pilot should be able to see along the runway based on his sighting of runway markers or lights at prevailing intensity settings. The RVR system is comprised of the transmissometer and the RVR computer. The transmissometer is located adjacent to the runway to measure ambient transmissivity while the RVR computer converts the transmissometer output into visibility in units of feet. At ACC's the Operational Information Display System (OIDS) performs the functions of the RVR computer. The RVR systems currently in use employ vacuum tube technology.

SURVEILLANCE

Density of air traffic is one of the major factors considered in determining the type of surveillance system used for air traffic control. Within Canadian airspace, surveillance in the high density traffic area (mainly over southern Canada) is provided by radar systems of which there are two types: Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR). In the low density traffic area (mainly over Northern Canada) and in the Oceanic area, surveillance is effected through the use of pilot position reports.

The position of targets (aircraft) and the location of weather in the PSR system is determined by measuring and displaying reflected signals (RF energy). The SSR system relies on reply signals transmitted from airborne electronic equipment called transponders. On aircraft equipped with altitude encoders, the transponder automatically transmits the aircraft's altitude. The SSR system is currently the main source of radar surveillance information used for ATC in both the enroute and terminal environments. Because SSR systems are unable to detect weather, PSR systems supplement SSR and give limited weather information. As well, PSR systems enable the detection of aircraft not equipped with transponders. Radar surveillance installations are comprised of either colocated PSR and SSR systems, or stand-alone SSR systems.

A number of the SSR systems of the Department of National Defence are also used by Transport Canada (as stand-alone SSR) to supplement enroute coverage.

At specific airports, where traffic warrants, surveillance of surface traffic is also provided. This equipment, known as Airport Surface Detection Equipment (ASDE) is used by tower controllers to monitor the position of aircraft and vehicles on the manoeuvering area of the airport (runways and taxiways) particularly during conditions of reduced visibility.

At present, Atmospheric Environment Services of Environment Canada (AES) owns and operates a number of C band weather radars. These systems are situated in the more populated areas of the country. The aviation community is but one of the many users of data derived from these systems.

The ATC radar surveillance equipment is antiquated and uses, for the most part, vacuum tube technology. Remote maintenance monitoring is not a feature of the present system.

COMMUNICATIONS

Ground-to-air communications facilities provide voice radio communications between controllers and pilots in both enroute and terminal airspace. Other ground-to-air facilities provide communication between pilots and flight service specialists.

Ground-air VHF and UHF communications stations, both local and remote, are located to give coverage for each air traffic control sector, as well as for FSS communications. About 50% of the existing communications transmitters and receivers use solid state technology and the remainder are due for replacement. UHF equipment is currently fully solid state. VHF equipment has been converted to 25 kHz spacing for use in the airspace above 18,000 ft. Conversion to 25 kHz channel spacing for low level airways and terminal areas will be implemented where frequency congestion occurs.

Long-range HF facilities are used to communicate with international flights over oceanic areas and in Northern Canada where it has not yet been economical or possible to provide complete VHF coverage. Generally, all the HF transmitters associated with international operations are modern but the receivers are old and will be replaced. The HF transmitters and receivers associated with domestic operations are also due for replacement.

Present communication facilities do not include remote maintenance monitoring.

THE NEW APPROACH

Conversion of ground-to-air systems to fully solid state design will continue; increased emphasis will be placed on implementation of remote maintenance monitoring for all systems; consolidation of navigation; communication and surveillance locations will be emphasized to reduce maintenance costs. New and more capable systems will be implemented such as Mode S with data link and the Microwave Landing System (MLS). Satellite/HF data link as well as supplementing Omega by VLF station(s) and by differential Omega will be further studied and implemented as appropriate. Dependent surveillance will be implemented whereby on-board navigation systems will provide air traffic control with automatic position data via HF/satellite data link.

To develop a nationwide integrated system of navigation, communications and surveillance, including weather radar coverage, the concept of networking will be used. These networks will result in significant improvements in availability of service and system back-up capability, ensuring full use of the coverage provided by these systems.

Surveillance systems development will see the replacement of all existing radar systems, both primary and secondary, and the incorporation of Mode S data link in the enroute secondary surveillance radars. Radar data obtained from military and U.S.A radars will be integrated into the surveillance network. The weather surveillance data provided by the primary ATC radars will be combined with dedicated weather radars to improve the real time weather picture for pilots, controllers and flight service specialists. Total coverage by these systems will be provided in the high density traffic area at and above 18,000 ft. and in critical areas at and above 12,500 ft. Below these altitudes coverage will be available along airways and in terminal control areas. In low density traffic areas, at and above 18,000 ft, surveillance will be provided by relaying airborne derived navigational information via a HF/satellite data link.

Navigation systems development will see the completion of a VOR-DME network which will ensure that navigational coverage is consistent with the coverage provided by surveillance radars in the high density traffic area. Similar coverage from communications systems and VHF direction finders will be available. Outside of radar coverage in the low density traffic area a network of DME's colocated with NDB's will provide for DME updating of airborne inertial navigation systems as well as improving navigation for aircraft flying at lower altitudes. Increased use of Omega will be encouraged by supplementing coverage with one or two VLF stations. Differential Omega will be considered for installation installed at selected locations. The concept of minimum navigation performance standards for operations at and above 18,000 ft. in the low density traffic area will be adopted. Installation of VOR-DME in the low density traffic area will be considered where traffic and operational considerations justify the requirement.

Landing systems development will see the complete replacement of the ILS by the new ICAO standard MLS by the end of the period and the implementation of category III operations at a small number of the busier airports. The withdrawal of ILS will commence soon after the ICAO protection date, 1995. Existing non-precision approach systems will continue to be utilized and will be supplemented by DME and differential Omega at selected locations. As ILS is withdrawn from service the locator NDB's will be retained, where required, to preserve the non-precision approach on that runway.

HOW THE SYSTEM WILL EVOLVE

NEAR TERM (TO 1985)

Most of the radar surveillance modifications and improvements will concentrate on stabilizing the performance of the aging sensors, using stop gap measures and off-the-shelf components, until their replacement under the Radar Modernization Project (RAMP).

Seven new solid state ASDE radars will be purchased and delivered in 1984-86 period. Installation of these systems will commence in 1984, and be completed by 1988. The ASDE radar now in use at Toronto International Airport will be replaced in late 1984 and the two leased systems, Vancouver and Mirabel, will be replaced in the 1984 to 1988 time frame.

Nine weather radars, owned by AES provide radar derived weather information for aviation purposes. A tenth radar, operated by McGill University, supplies displayed weather data to the Montreal Airport briefing office. Four of the present nine AES weather radars are being replaced by new solid state equipment. Five additional radars will be installed to provide expanded coverage and enhance aviation forecasts. Conversion of VOR systems to solid state technology will be completed by 1988. Plans for retrofitting existing installations with automatic ground checking and remote maintenance monitoring will be finalized. Plans will also be finalized with DND for the TACAN modernization program to begin in 1985 and to be completed by 1990. The Enroute NDB modernization program will continue at a rate of approximately 20 per year in order to complete the program by 1988. Converting to voice identification on NDB's will be investigated and the continuous broadcasting of weather information will be incorporated on NDB's. The implementation of remote maintenance monitoring for NDB's will begin.

During this period, to expand enroute coverage, approximately 9 VOR/DME's, 10 VHF/DF's and 20 NDB's will be installed. Plans for expansion, consolidation and relocation of navigation and communications facilities beyond 1985 will be finalized based on the need to cater to area navigation requirements and reduced maintenance.

For the low density traffic area, Differential Omega and VLF coverage to supplement Omega will be further studied in order to finalize the technical requirements for these systems and to establish an appropriate implementation plan.

The conversion of non-precision approach equipment to solid state will continue during this period. No change in the type of systems in use is expected although engineering development work for using differential OMEGA as a non-precision approach aid will continue. Expansion of NDB installations will continue at a rate of about 5 per year. Four new LOC/DME systems will be installed in the period. VOR/DME installations will not be carried out specifically for the purpose of an instrument approach aid although some new enroute VOR/DME's may be dual purpose.

Existing plans to replace all but 17 aging tube type ILS installations with solid state equipment will be completed by 1985 and plans will be developed to replace the remainder by 1988. In addition, 15 new ILS installations will be completed by 1987.

An engineering test MLS system will be installed and used for development of technical and operational standards and procedures. An additional 4 systems are planned to support the STOL operation between Toronto, Montreal and Ottawa. A Plan for the transition from ILS to MLS will be completed. Developmental work will be carried out on Precision DME (DME-P) equipment and procurement specifications will be completed.

The RVR transmissometers will be replaced with solid state units and modernization of the RVR computers and displays will begin. New installations will incorporate the new designs beginning in 1983 for the transmissometers and 1984 for the computer and associated displays.

Communication improvements will focus on replacing obsolete vacuum tube type equipment with solid-state technology. Additional communication facilities will also be provided particularly in northern areas. Installation of remote maintenance monitoring for communication systems will begin during this period. Conversion of communications equipment to 25 kHz channel spacing capability will be completed.

INTERMEDIATE TERM (TO 1990)

The Radar Modernization Project (RAMP) will upgrade the present radar systems with new solid-state, primary and secondary surveillance radar systems. The new Primary Surveillance Radar (PSR) will employ advanced signal processing, permitting improved target and weather detection. The Secondary Surveillance Radar (SSR) system will employ monopulse techniques for greater positional accuracy and will be completely upgradable to Mode S data link operation.

PSR, which will be installed at qualifying airports, will provide aircraft surveillance coverage out to 80 nm. Colocated SSRs will provide coverage out to 250 nm and up to 70,000 feet. Full SSR coverage will be provided at 18,000 feet and above throughout the high density traffic area, through the utilization of additional stand-alone SSRs. Hazardous weather will be detected by the PSR out to 100 nm. Digital remoting of radar data will be used extensively to provide surveillance and weather information to the appropriate Air Traffic Services facilities.

The installation of new, solid state ASDE radar systems will continue to 1988. Engineering and development aimed at providing target identification tags on the ASDE displays will commence in this period.

The provision of AES derived weather radar data, combined with satellite derived weather data will be provided for ATS purposes, through increased use of digital remoting of data. A basic level of ATS meteorological processing will provide directly interpretable weather information.

Conversion of all ground based enroute navigation systems to solid state technology will be completed and implementation of remote maintenance monitoring for these facilities will be near completion. Expansion of VOR/DME coverage within the high density traffic area will allow for area navigation at or above 18,000 ft. In the low density traffic area, DME coverage will be expanded by colocating DME at selected NDB's. This will provide for improved DME updating of INS as well as improving the navigation environment for low level and non-INS equipped aircraft. To further assist aircraft at all altitudes, VLF coverage will be implemented to supplement Omega in North and Central Canada. The installation of Differential Omega in conjunction with selected NDB's will be considered to provide increased accuracy within aerodrome areas in Northern Canada. During this period approximately 20 new VOR/DMEs, 15 stand alone DME's, 30 NDB's, 1 VLF station and 5 Differential Omega installations are expected to be completed. The VHF/DF network will continue to expand to satisfy terminal area requirements. VHF/DF data will be inputted to the radar data processing system to allow controllers to use DF information for enroute purposes.

Engineering development work will be carried out to establish and test the satellite/HF data link system which will provide surveillance capability within the low density traffic area. Coordination will be carried out with industry and interested countries to ensure the compatibility of the proposed system with Mode S data link and to bring suitable airborne interface equipment onto the market.

Due to the commencement in 1986 of MLS installations, at a rate of 10 per year, the installation of new and replacement ILS's will terminate by the year 1987. During the period remote maintenance monitoring will be integrated into existing ILS installations while the new MLS installations will include remote maintnenance monitoring at the time of installation. DME-P will be incorporated into MLS's installations and by 1990 all existing and future MLS will include DME-P. Existing DME's at ILS installations will be replaced by DME-P to release the higher power DME equipment for use as enroute facilites.

Existing RVR computers will be upgraded complete with remote maintenance monitoring and solid state displays. Development work will be carried out in the area of sensor stabilization and alternative light sources. The number of installations will be increasd to provide ground visibility information in the take-off zones at major airports.

High Frequency (HF) communication facilities will be converted to solid-state. Total VHF communication coverage at 12,500 feet and above in the high density traffic area will be completed. Consolidation of compatible communications navigation and radar equipment into common buildings will be carried out where cost savings and improved reliability can be achieved.

LONG TERM (TO 2000)

The monopulse SSR radars will be upgraded to provide continuous Mode S data link coverage above an altitude of 18,000 ft (12,500 ft in critical areas) and down to the surface at qualifying airports in the high density traffic area. To obtain automated air traffic control clearance aircraft will have to be equipped with Mode S transponders. This will improve the ATC systems capability of providing separation assurance and increase air traffic control flexibility and efficiency. An automatic aviation weather response system will be available to pilots by data link. ATC messages will be transmitted by data link to the cockpit.

Improved weather detection will result from adding to and upgrading of the weather radar network. This network will ensure weather radar coverage above 18,000 feet throughout the high density traffic area.

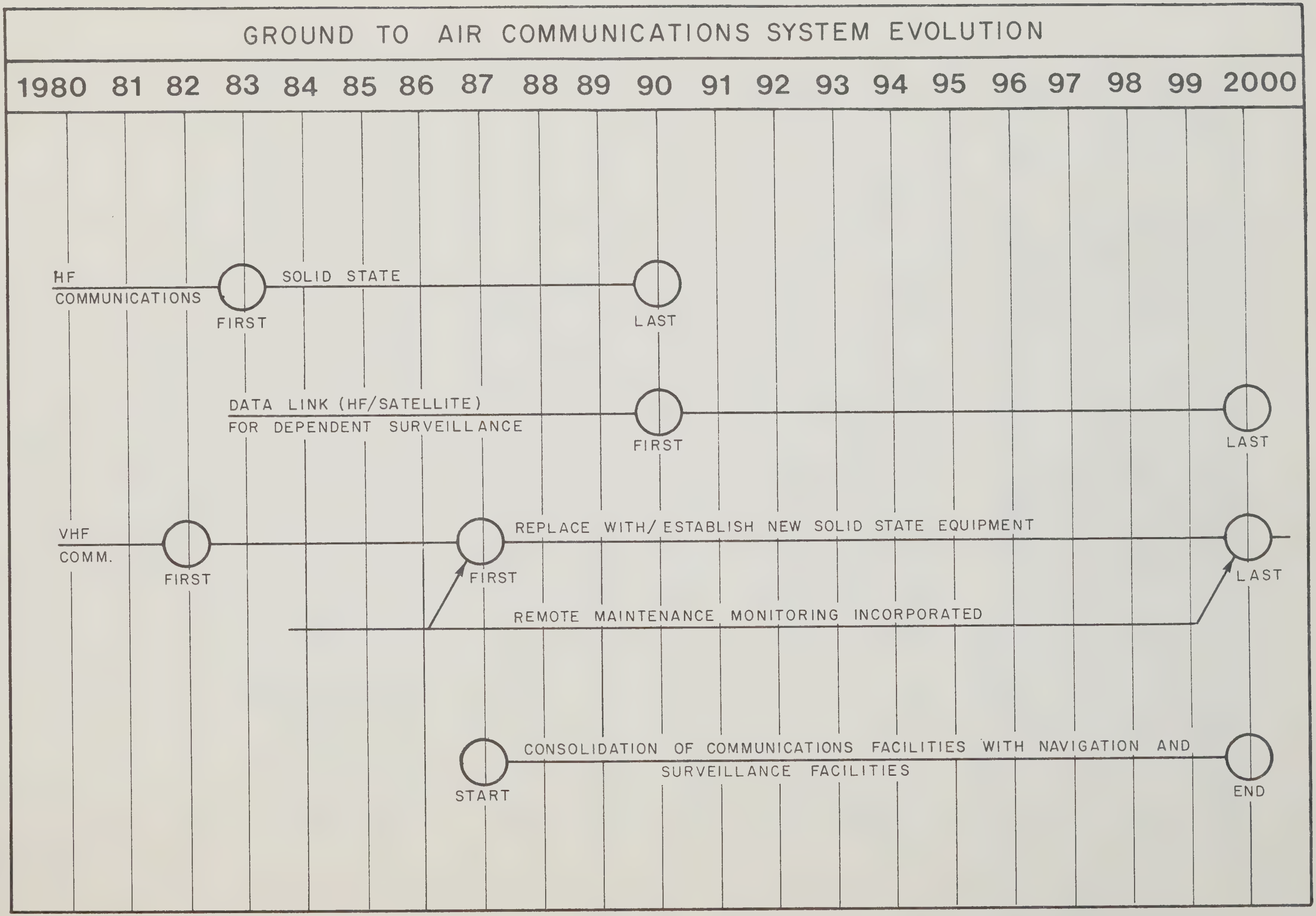
Additional ASDE systems will be provided for qualifying airports. Display systems for the airport traffic will include the capability to display aircraft identification tags for the aircraft.

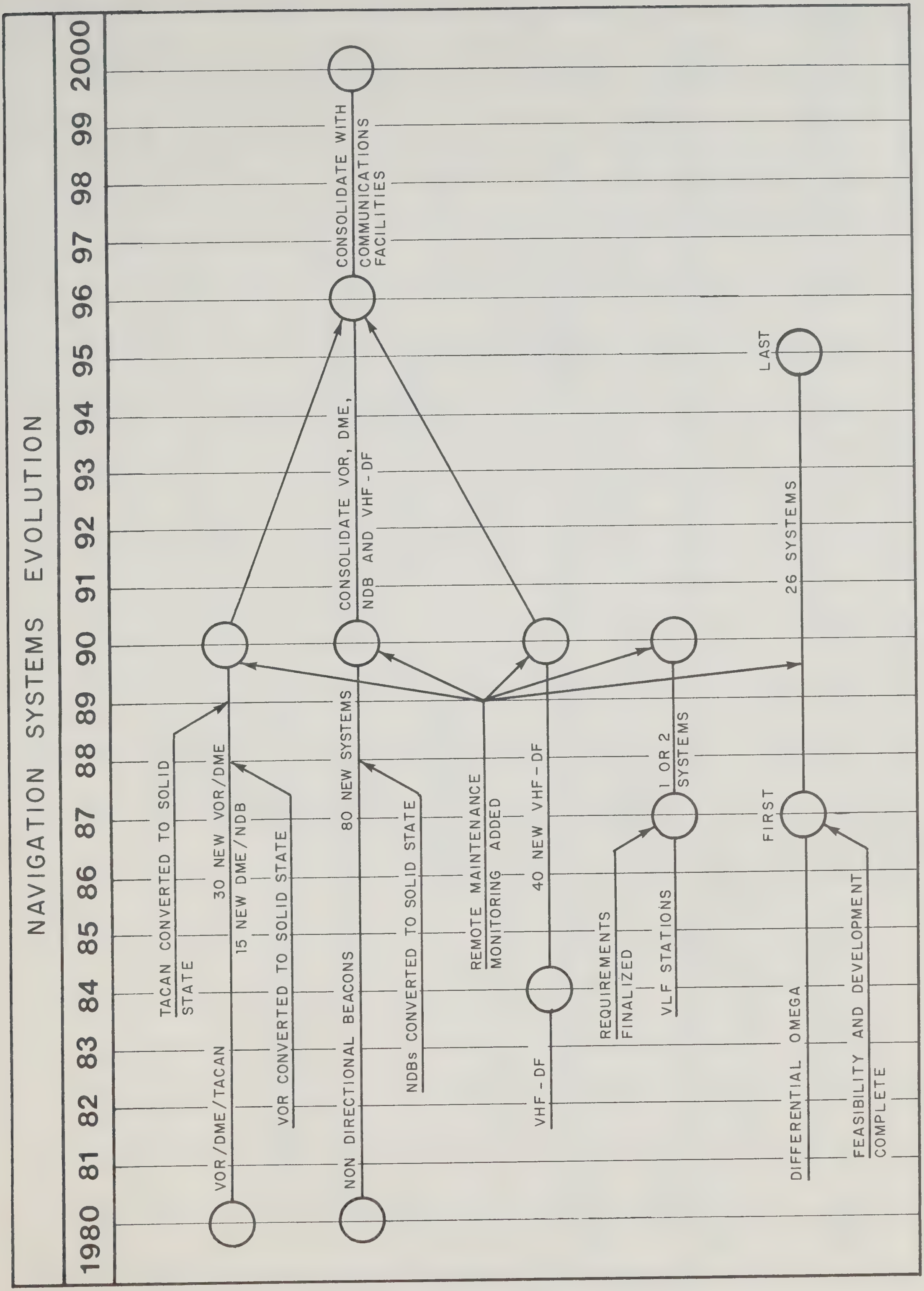
Surveillance for the low density traffic area and in the oceanic area will be provided through dependent surveillance techniques. In these areas, on board navigational equipment will provide positional data to ATS facilities via satellite/HF data links.

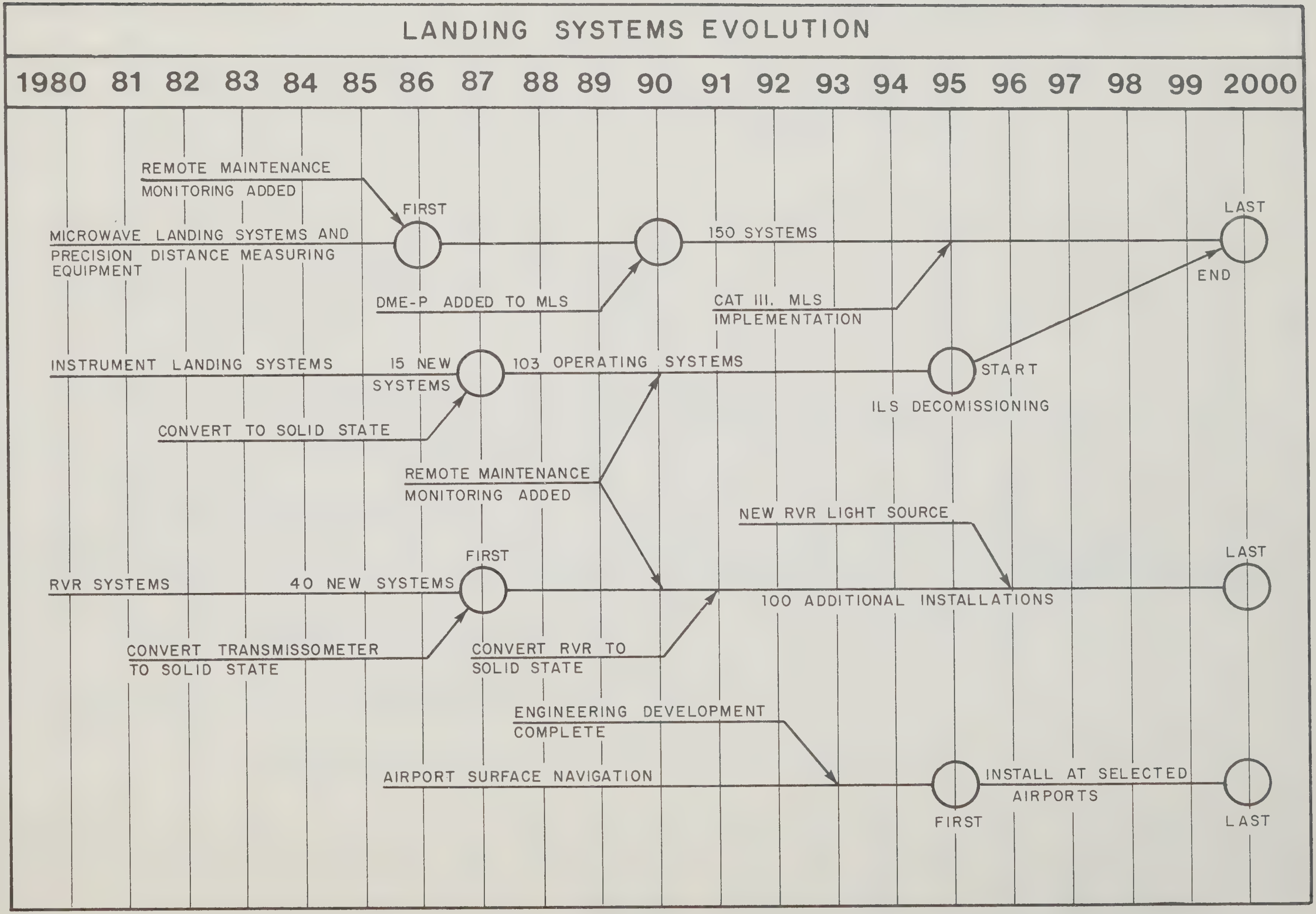
Expansion of the ground based DME system, NDB's,Differential Omega installations and the installation of an additional VLF station will provide improvements in low level navigation capability and complete the DME coverage so that INS updating throughout low density traffic area will be virtually continuous. At this point, the combination of navigation derived surveillance via data link with the ground derived and air derived navigation data will provide the basis for eventual transition, after 2000, to a satellite based navigation, surveillance and communication system.

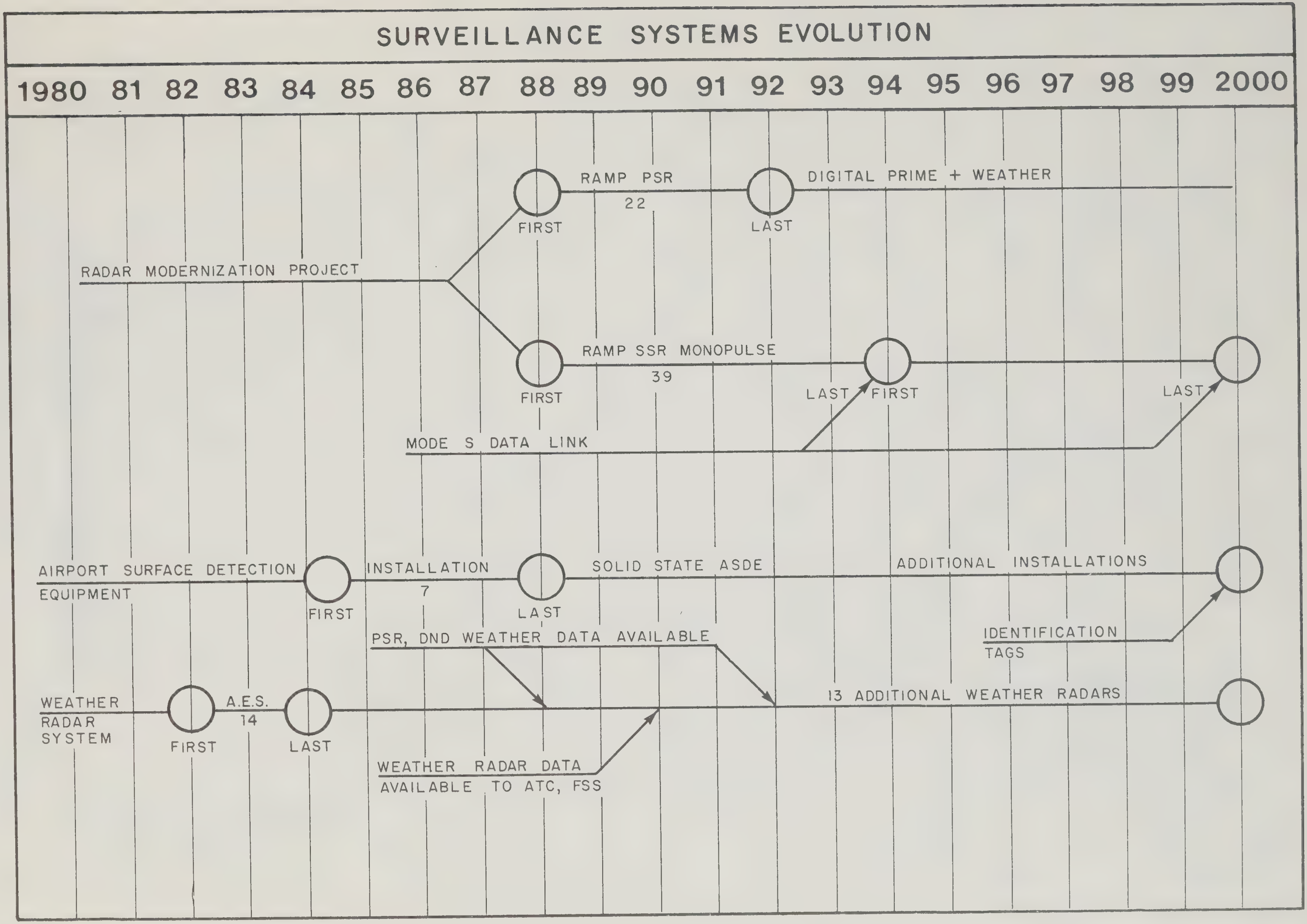
ILS systems will be decommissioned over the period 1995 to 2000. MLS installations will be carried out at a rate of 12 per year between 1990 and 1995 and at a rate of 10 per year between 1995 and 2000. Consideration will be given to redeploying some localizer equipments as LOC/DME installations. Consideration will also be given to installing the azimuth portion of the MLS for track guidance purposes where justified. Category III MLS will be installed, where justified, at qualifying airports. Development work on a new precision surface navigation system will be carried out prior to the implementation of CAT III.

Engineering development work will be carried out during this period to establish the potential of satellites for navigation, communications and surveillance purposes.


GROUND TO AIR COMMUNICATIONS SYSTEM EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
HF COMMUNICATIONS
FIRST
SOLID STATE
LAST
DATA LINK (HF/SATELLITE) FOR DEPENDENT SURVEILLANCE
FIRST
LAST
VHF COMM.
FIRST
FIRST
REPLACE WITH/ ESTABLISH NEW SOLID STATE EQUIPMENT
LAST
REMOTE MAINTENANCE MONITORING INCORPORATED
START
CONSOLIDATION OF COMMUNICATIONS FACILITIES WITH NAVIGATION AND SURVEILLANCE FACILITIES
END

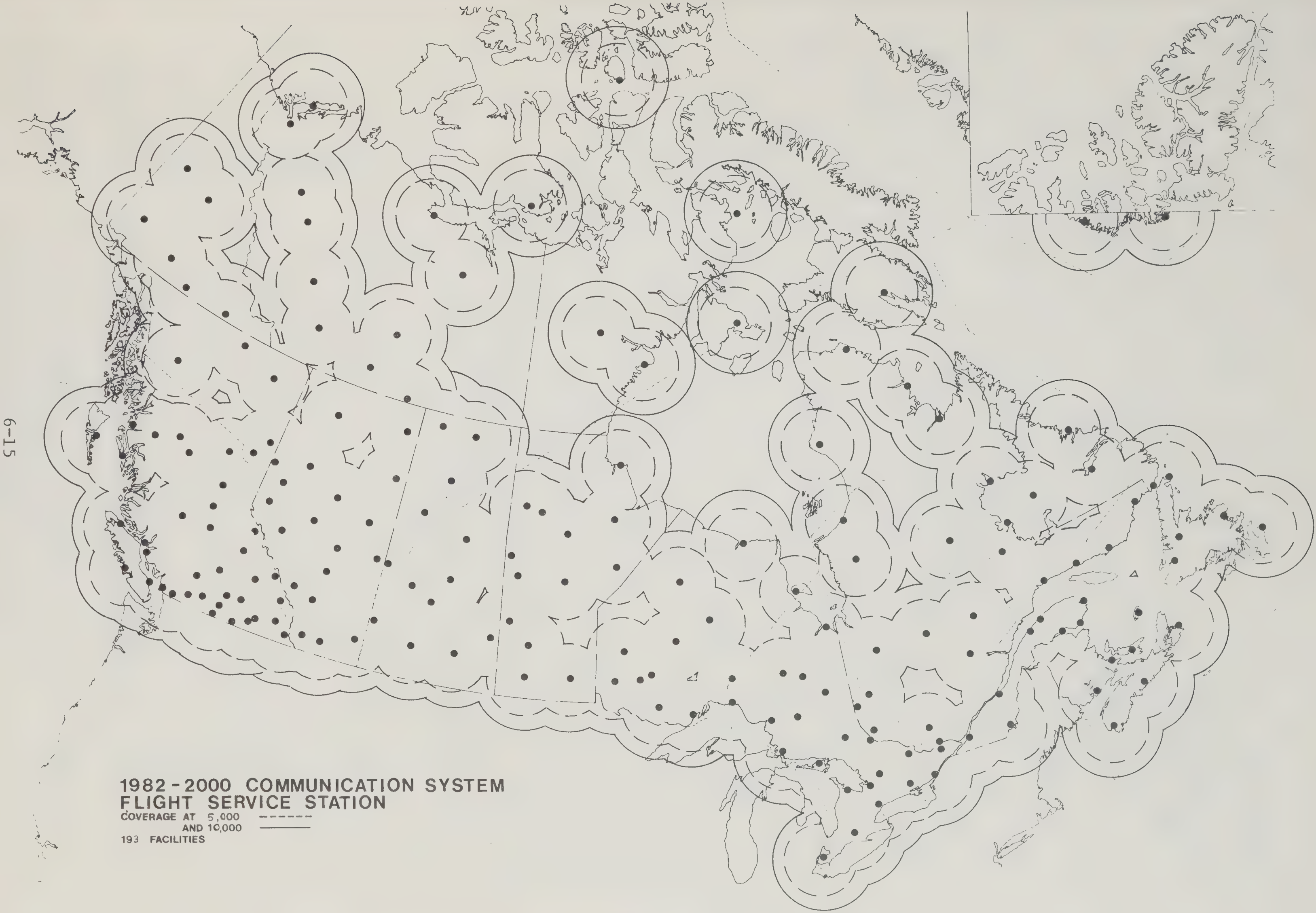

NAVIGATION SYSTEMS EVOLUTION
1980
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
2000
VOR/DME/TACAN
TACAN CONVERTED TO SOLID STATE
30 NEW VOR/DME
15 NEW DME/NDB
VOR CONVERTED TO SOLID STATE
NON DIRECTIONAL BEACONS
80 NEW SYSTEMS
NDBs CONVERTED TO SOLID STATE
CONSOLIDATE VOR, DME, NDB AND VHF-DF
CONSOLIDATE WITH COMMUNICATIONS FACILITIES
REMOTE MAINTENANCE MONITORING ADDED
VHF-DF
40 NEW VHF-DF
REQUIREMENTS FINALIZED
VLF STATIONS
1 OR 2 SYSTEMS
DIFFERENTIAL OMEGA
FEASIBILITY AND DEVELOPMENT COMPLETE
FIRST
26 SYSTEMS
LAST

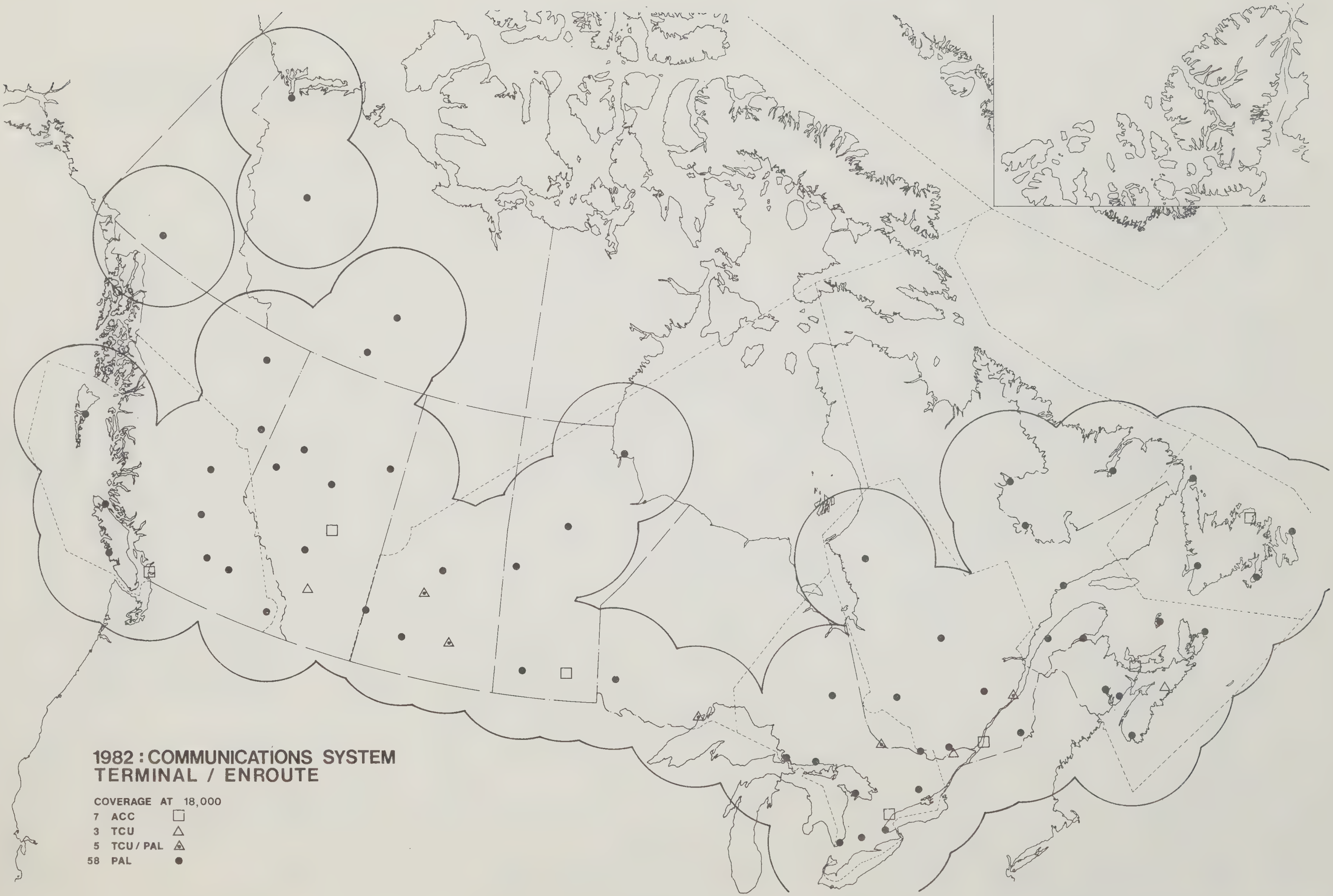

LANDING SYSTEMS EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
REMOTE MAINTENANCE MONITORING ADDED
FIRST
LAST
MICROWAVE LANDING SYSTEMS AND PRECISION DISTANCE MEASURING EQUIPMENT
150 SYSTEMS
END
DME-P ADDED TO MLS
CAT III. MLS IMPLEMENTATION
INSTRUMENT LANDING SYSTEMS
15 NEW SYSTEMS
103 OPERATING SYSTEMS
START
ILS DECOMISSIONING
CONVERT TO SOLID STATE
REMOTE MAINTENANCE MONITORING ADDED
NEW RVR LIGHT SOURCE
FIRST
LAST
RVR SYSTEMS
40 NEW SYSTEMS
100 ADDITIONAL INSTALLATIONS
CONVERT TRANSMISSOMETER TO SOLID STATE
CONVERT RVR TO SOLID STATE
ENGINEERING DEVELOPMENT COMPLETE
AIRPORT SURFACE NAVIGATION
INSTALL AT SELECTED AIRPORTS
FIRST
LAST



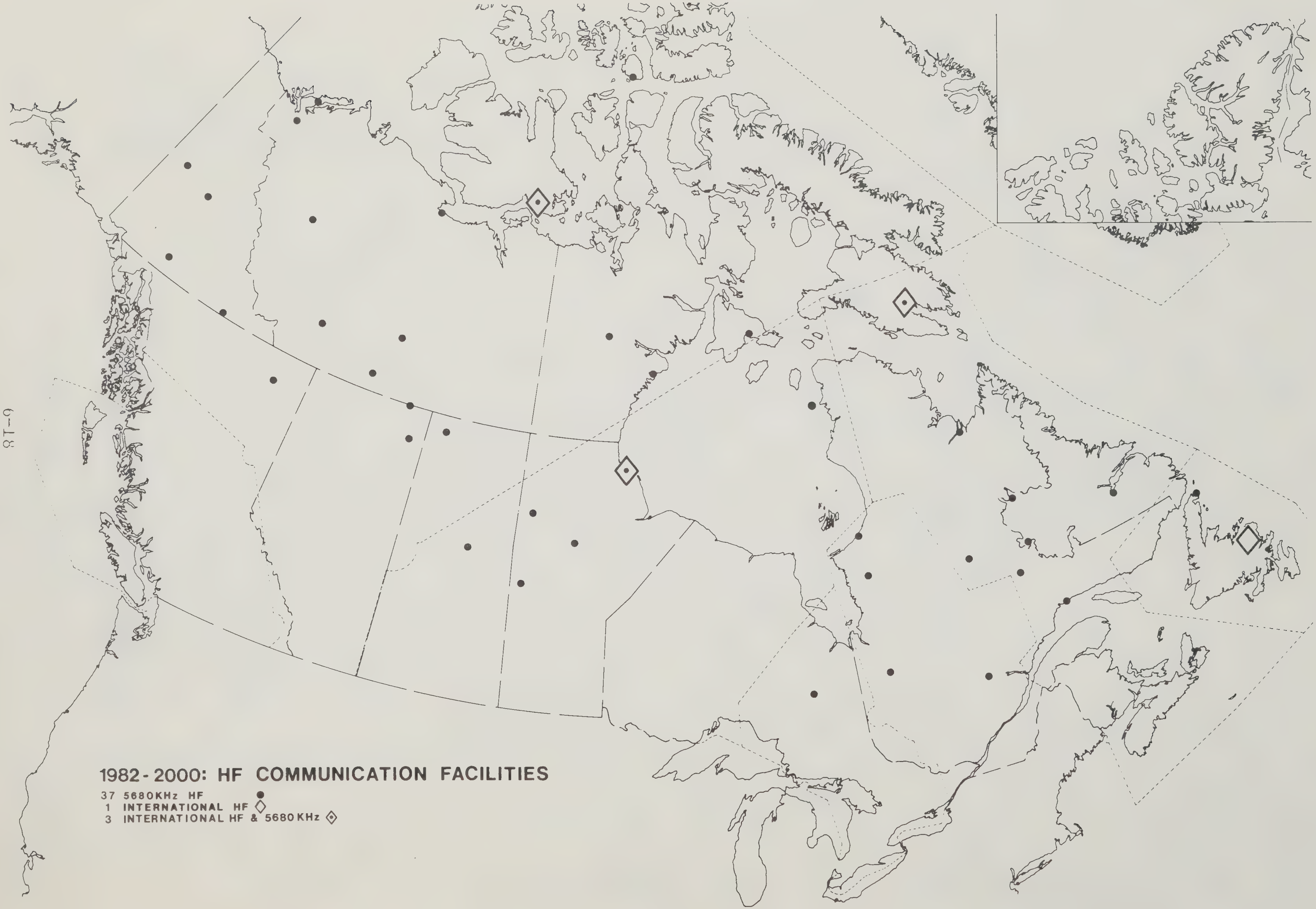
SURVEILLANCE SYSTEMS EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
RAMP PSR
22
FIRST
LAST
DIGITAL PRIME + WEATHER
RADAR MODERNIZATION PROJECT
RAMP SSR MONOPULSE
39
FIRST
LAST
FIRST
LAST
MODE S DATA LINK
AIRPORT SURFACE DETECTION EQUIPMENT
INSTALLATION
7
FIRST
LAST
SOLID STATE ASDE
ADDITIONAL INSTALLATIONS
IDENTIFICATION TAGS
PSR, DND WEATHER DATA AVAILABLE
WEATHER RADAR SYSTEM
A.E.S.
14
FIRST
LAST
13 ADDITIONAL WEATHER RADARS
WEATHER RADAR DATA AVAILABLE TO ATC, FSS


1982 - 2000: COMMUNICATION SYSTEM
FLIGHT SERVICE STATION
COVERAGE AT 12,500
AND 18,000
193 FACILITIES

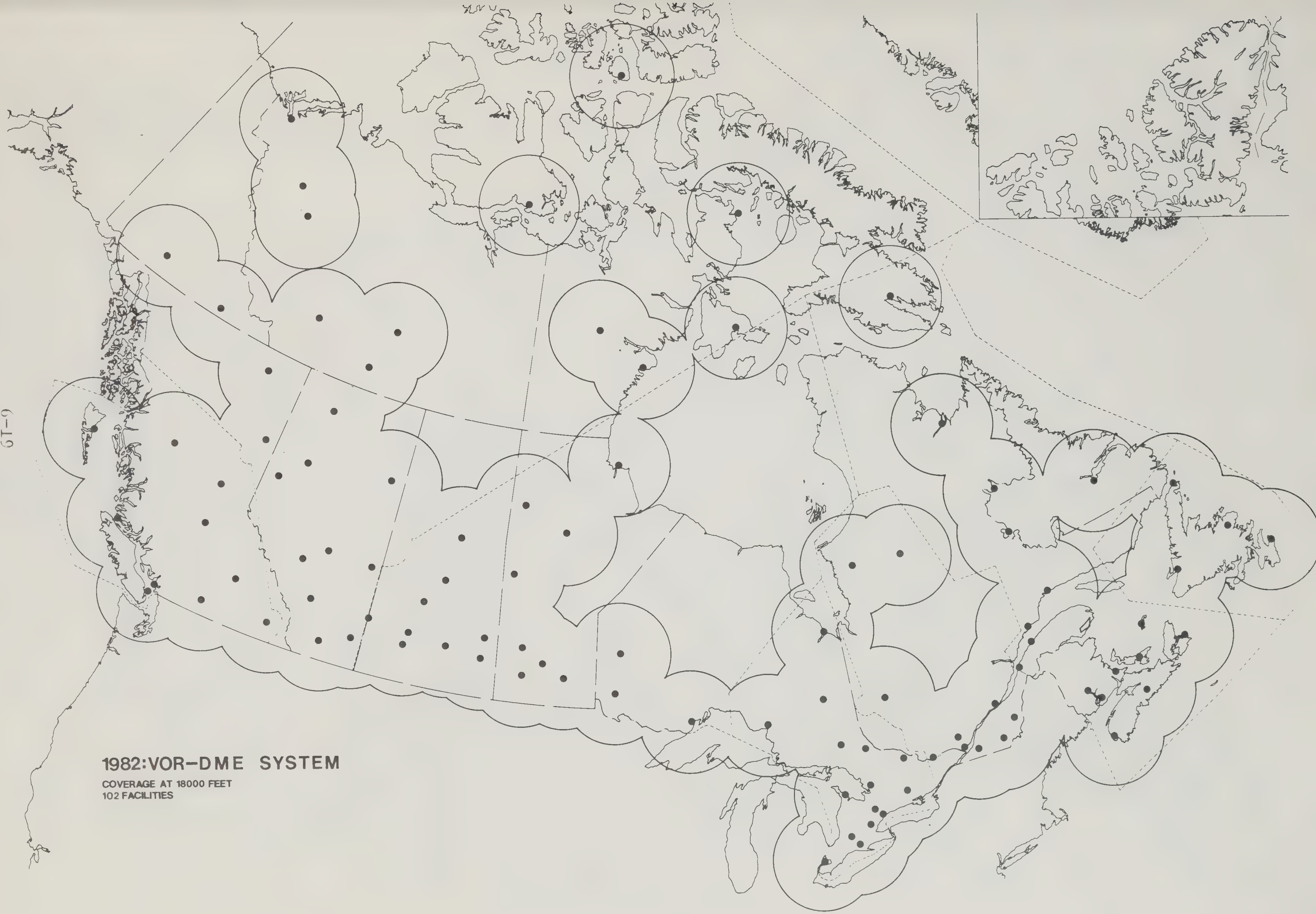

1982 - 2000 COMMUNICATION SYSTEM
FLIGHT SERVICE STATION
COVERAGE AT 5,000
AND 10,000
193 FACILITIES


1982 : COMMUNICATIONS SYSTEM
TERMINAL / ENROUTE
COVERAGE AT 18,000
7 ACC
3 TCU
5 TCU / PAL
58 PAL


1990-2000:COMMUNICATION SYSTEM
TERMINAL ENROUTE
COVERAGE AT 12,500 -----
AND 18,000 ——
7 ACC □
2 TCU △
6 TCU/PAL
76 PAL ●

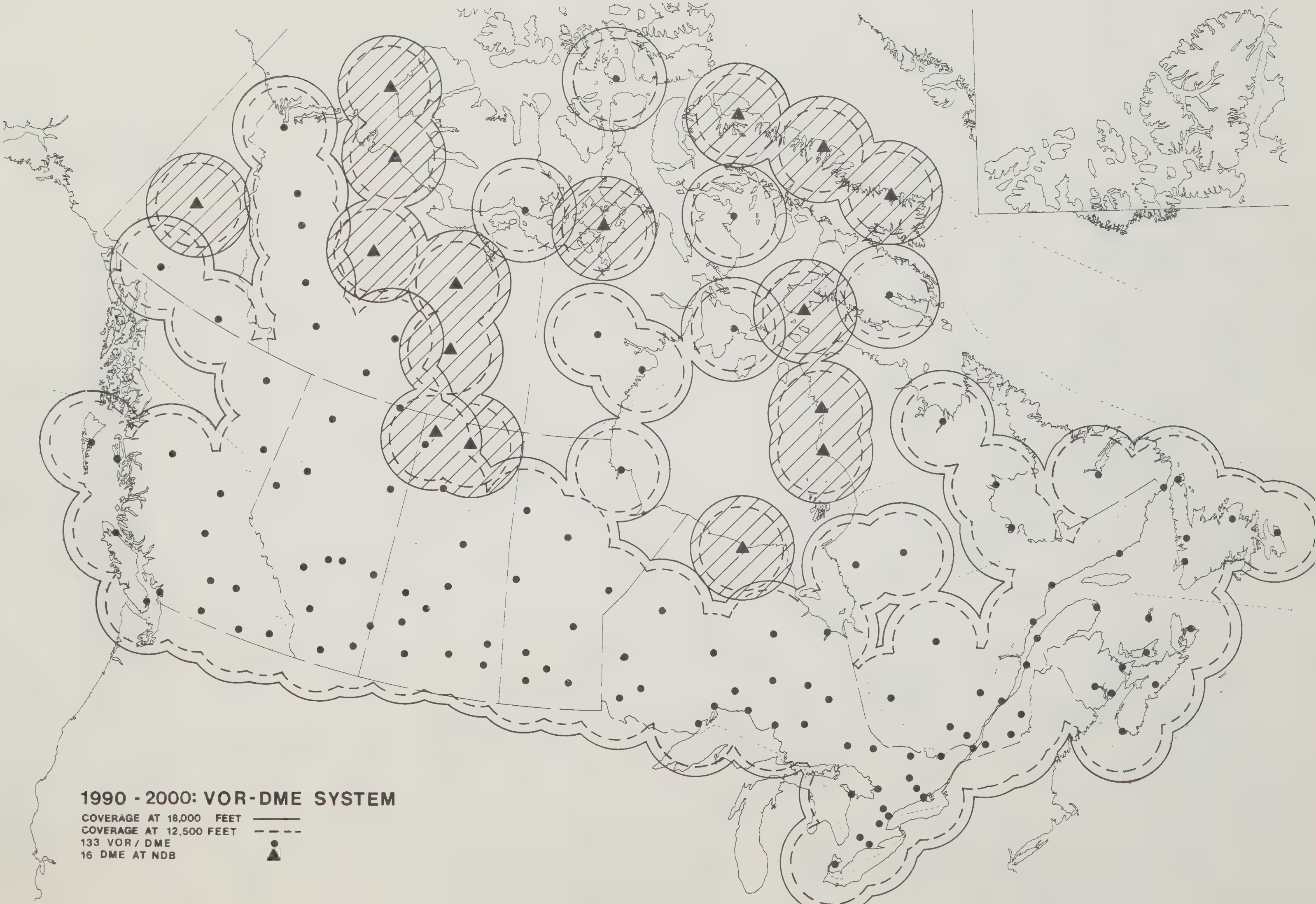


1982-2000: HF COMMUNICATION FACILITIES



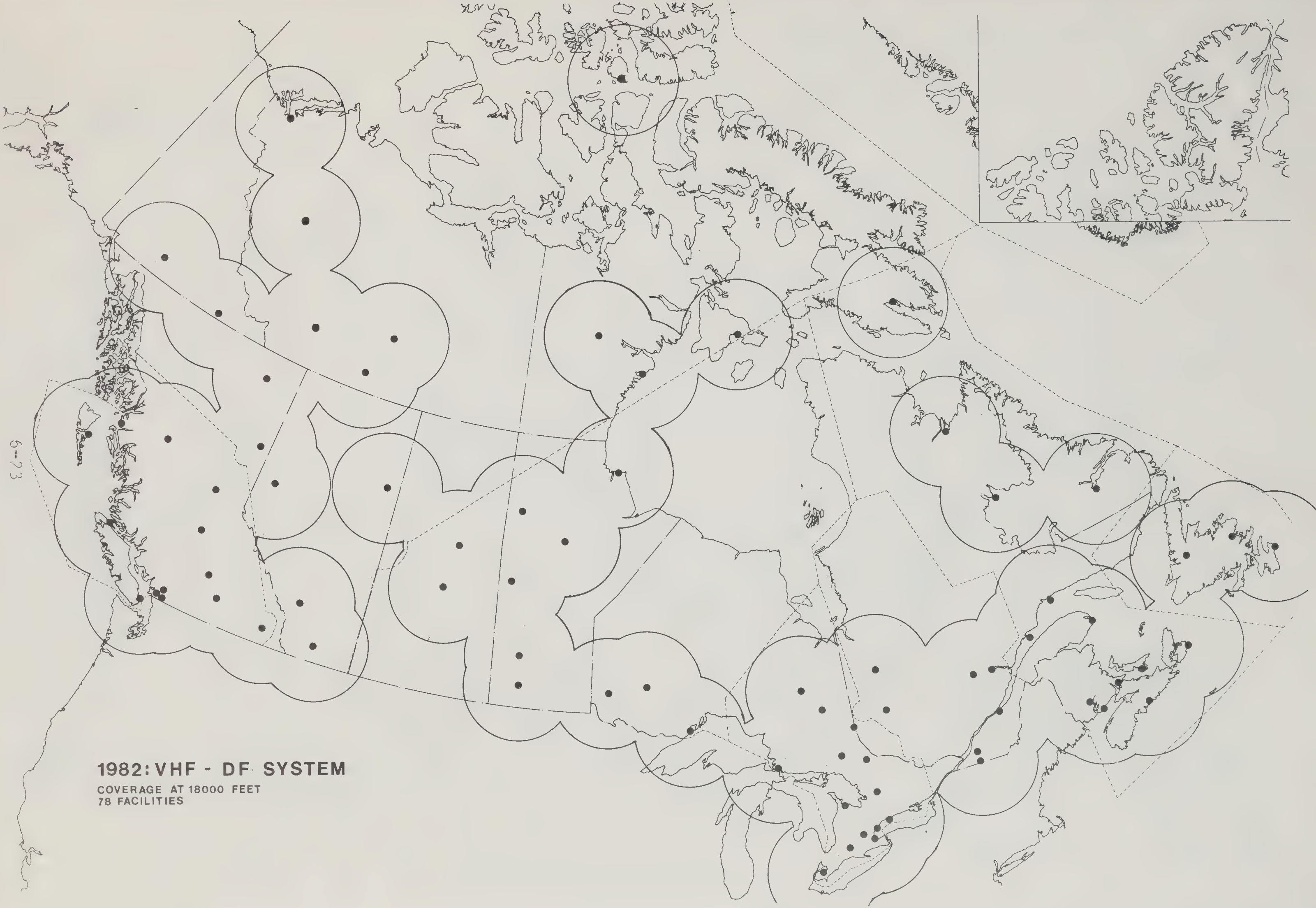
1982:VOR–DME SYSTEM

COVERAGE AT 18000 FEET
102 FACILITIES

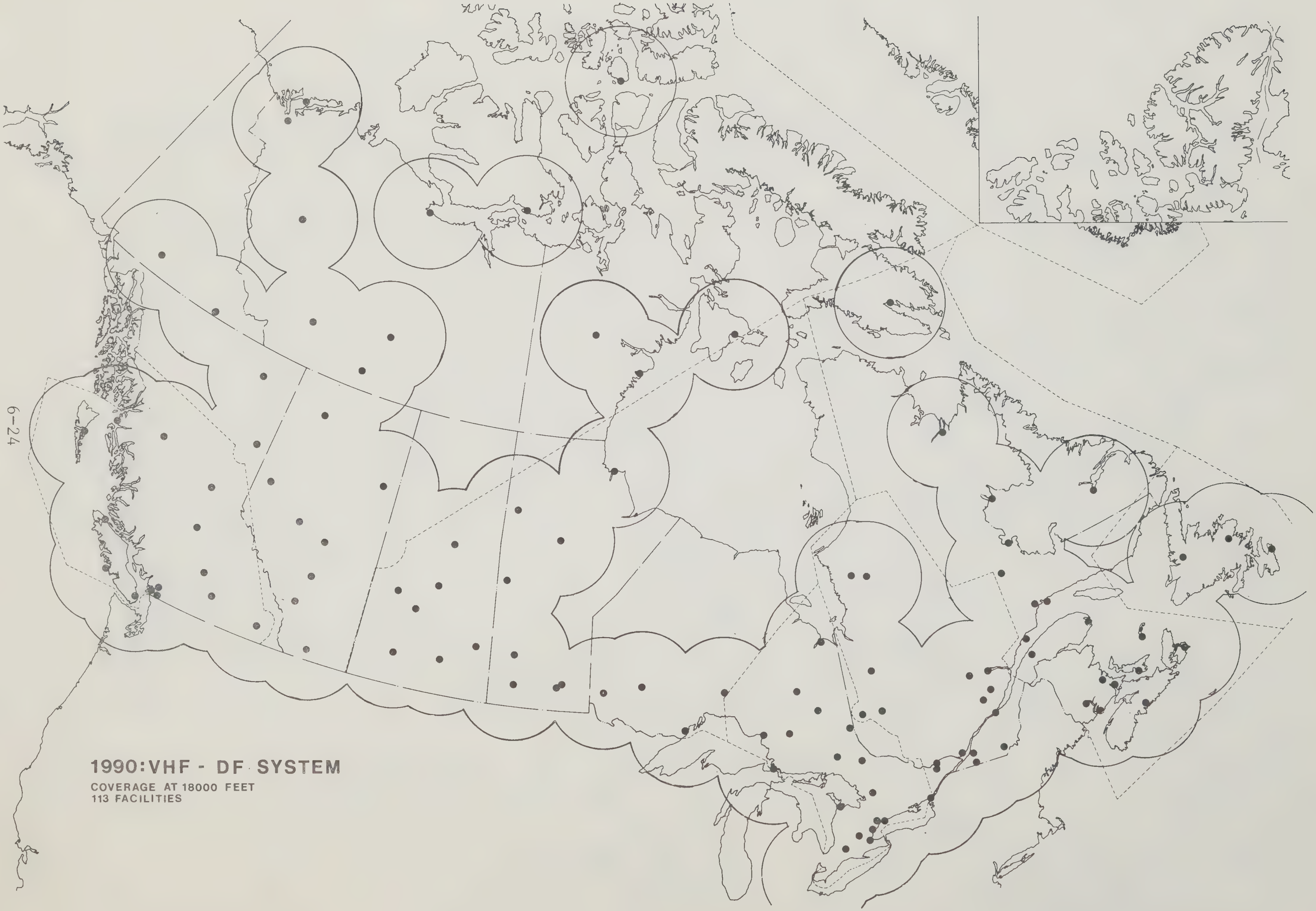

1990 - 2000: VOR-DME SYSTEM
COVERAGE AT 18,000 FEET
COVERAGE AT 12,500 FEET
133 VOR / DME
16 DME AT NDB

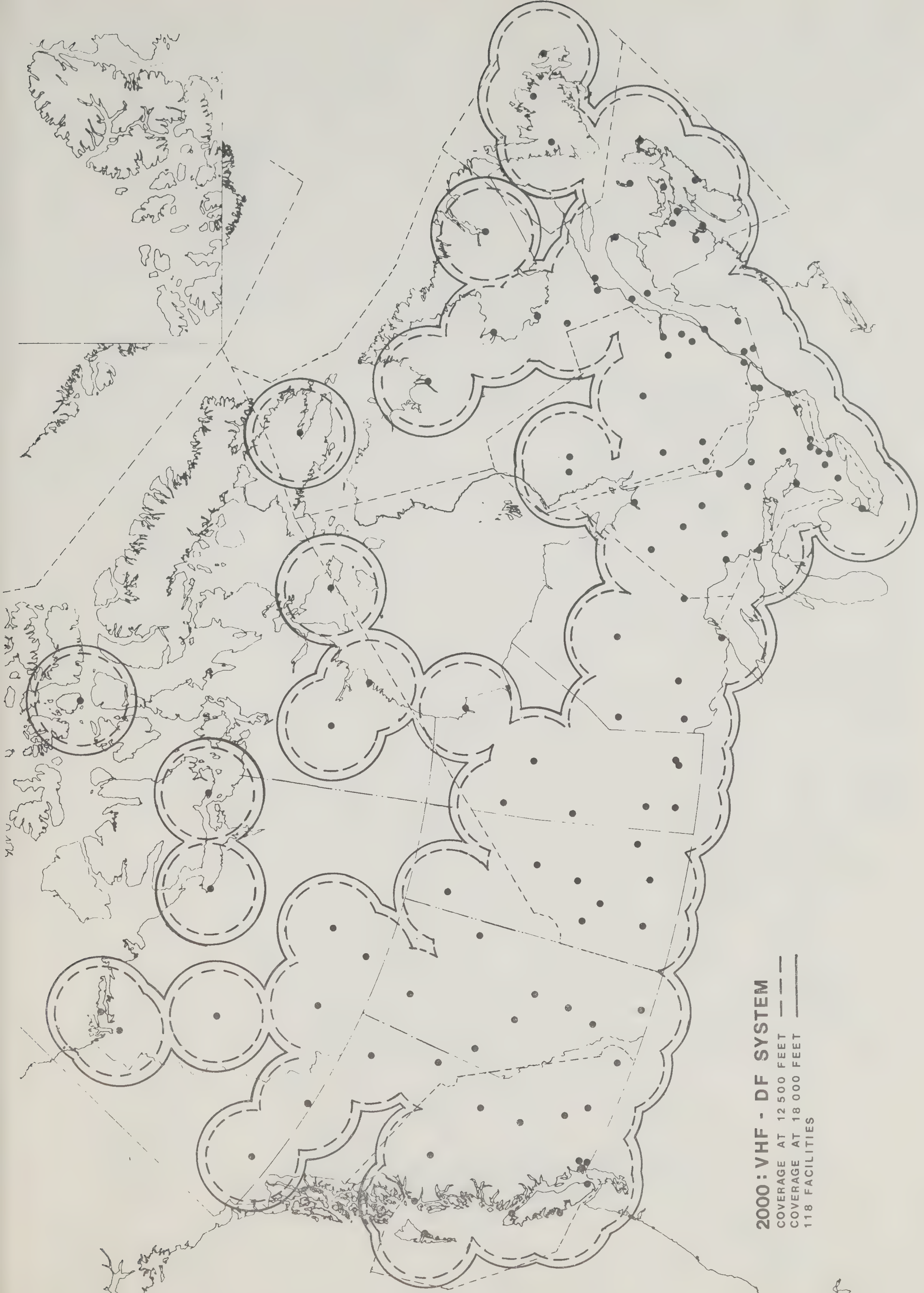

1982: ENROUTE NDB SYSTEM
203 CIVIL SITES ●
28 MILITARY SITES △

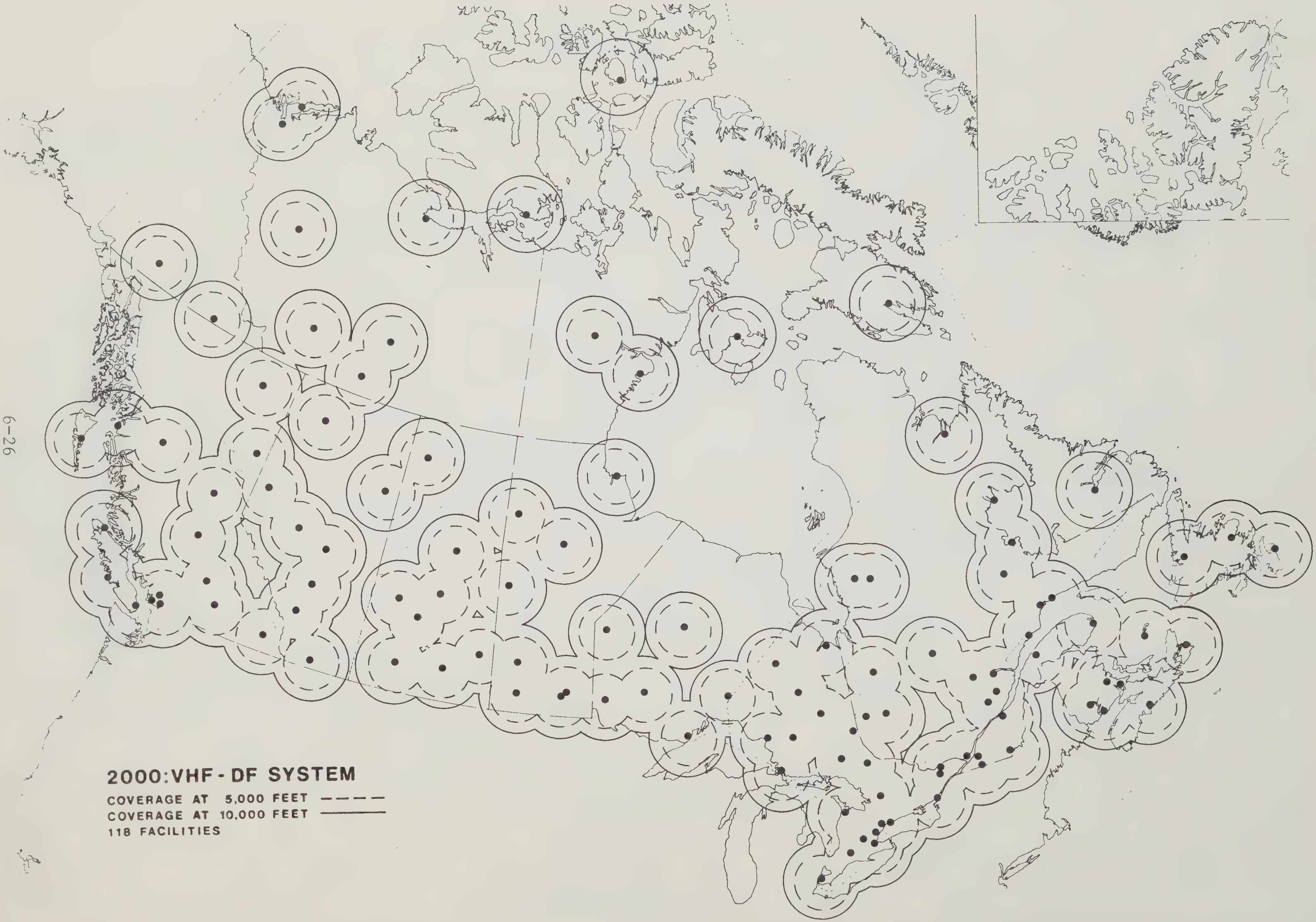

1990-2000: ENROUTE NDB SYSTEM
239 CIVIL SITES ●
28 MILITARY SITES △



1982: VHF - DF SYSTEM
COVERAGE AT 18000 FEET
78 FACILITIES

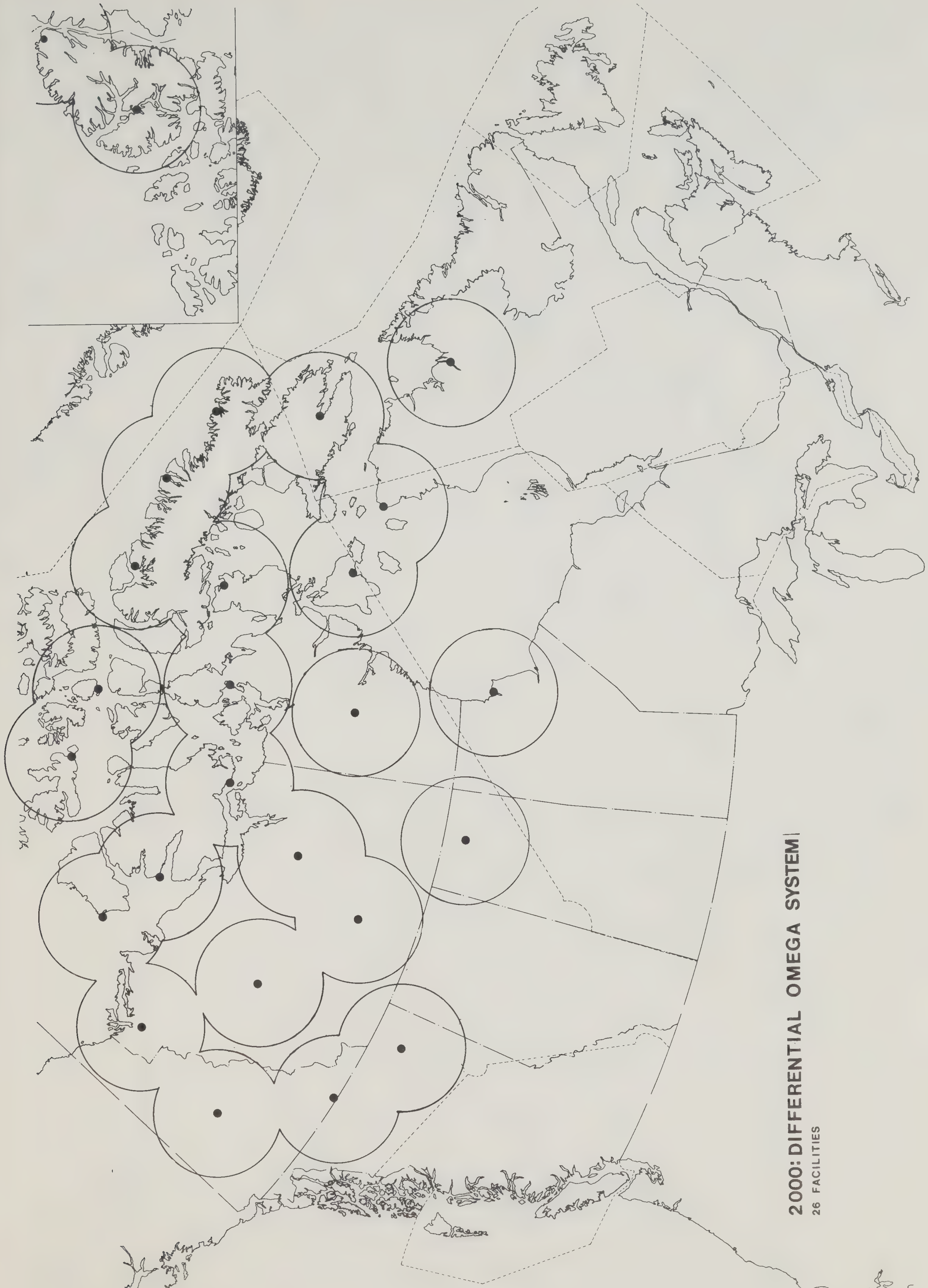

1990:VHF - DF SYSTEM
COVERAGE AT 18000 FEET
113 FACILITIES

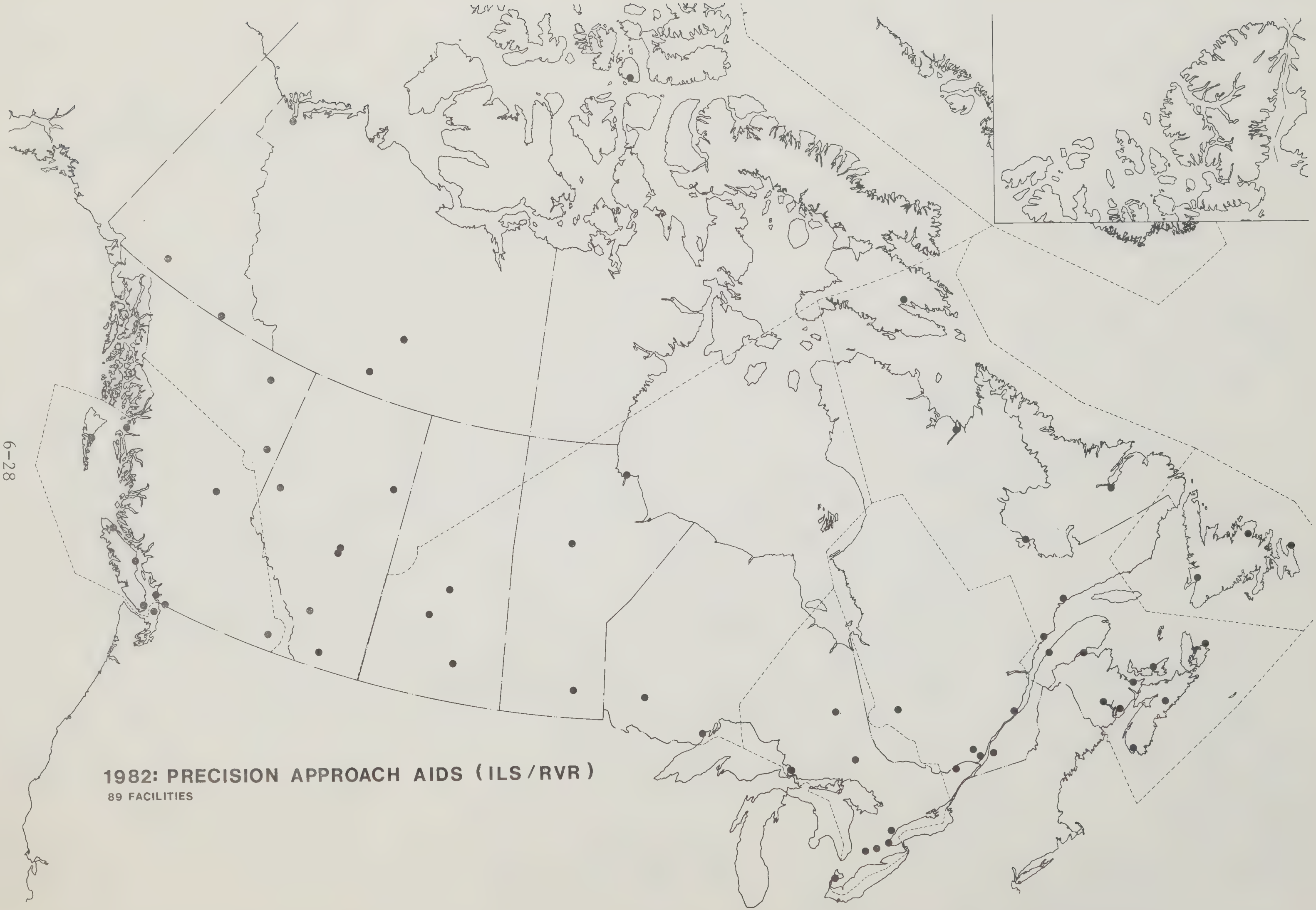

2000: VHF - DF SYSTEM
COVERAGE AT 12 500 FEET
COVERAGE AT 18 000 FEET
118 FACILITIES



2000: VHF - DF SYSTEM

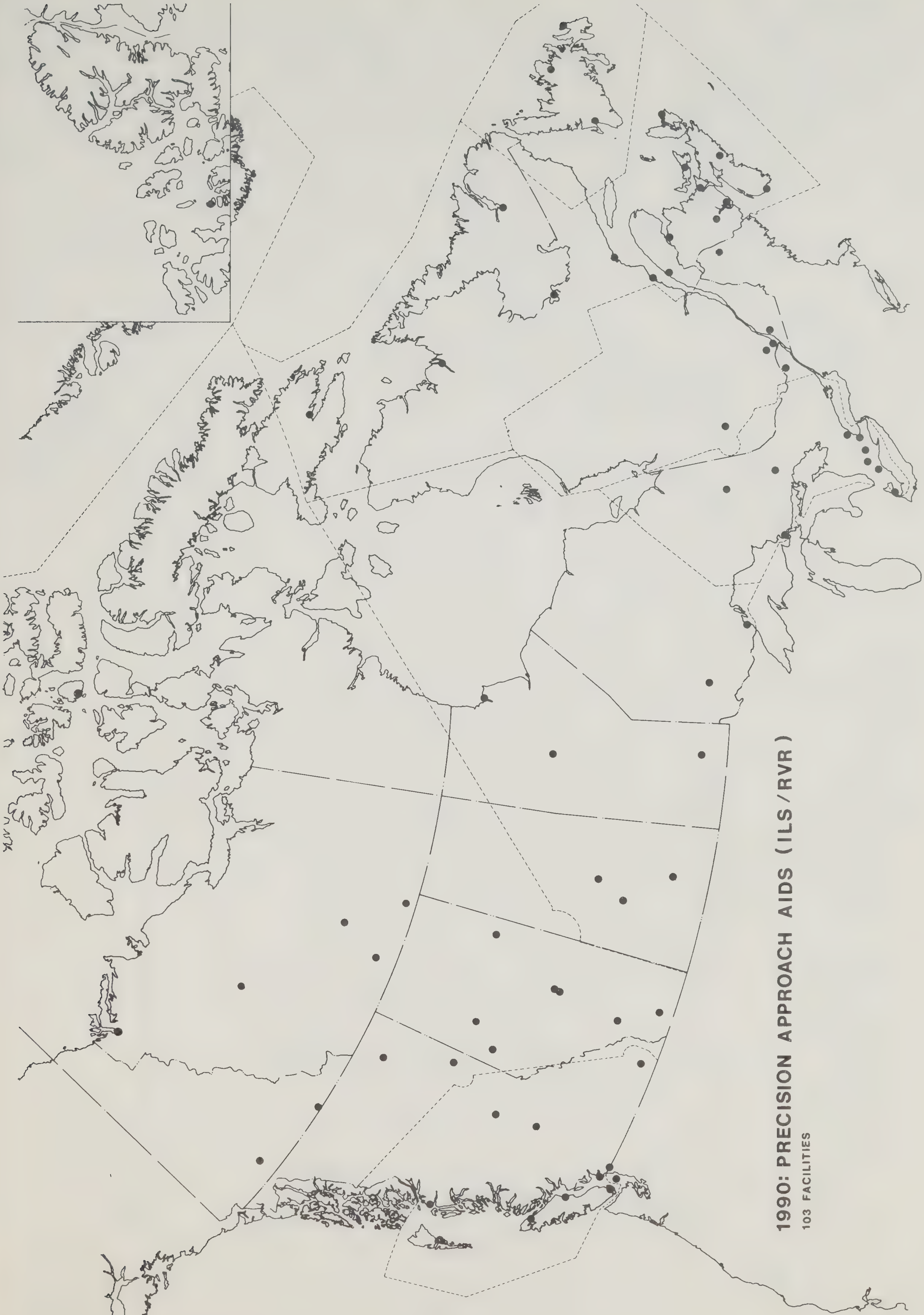
COVERAGE AT 5,000 FEET - - - -
COVERAGE AT 10,000 FEET ———
118 FACILITIES


2000: DIFFERENTIAL OMEGA SYSTEM
26 FACILITIES

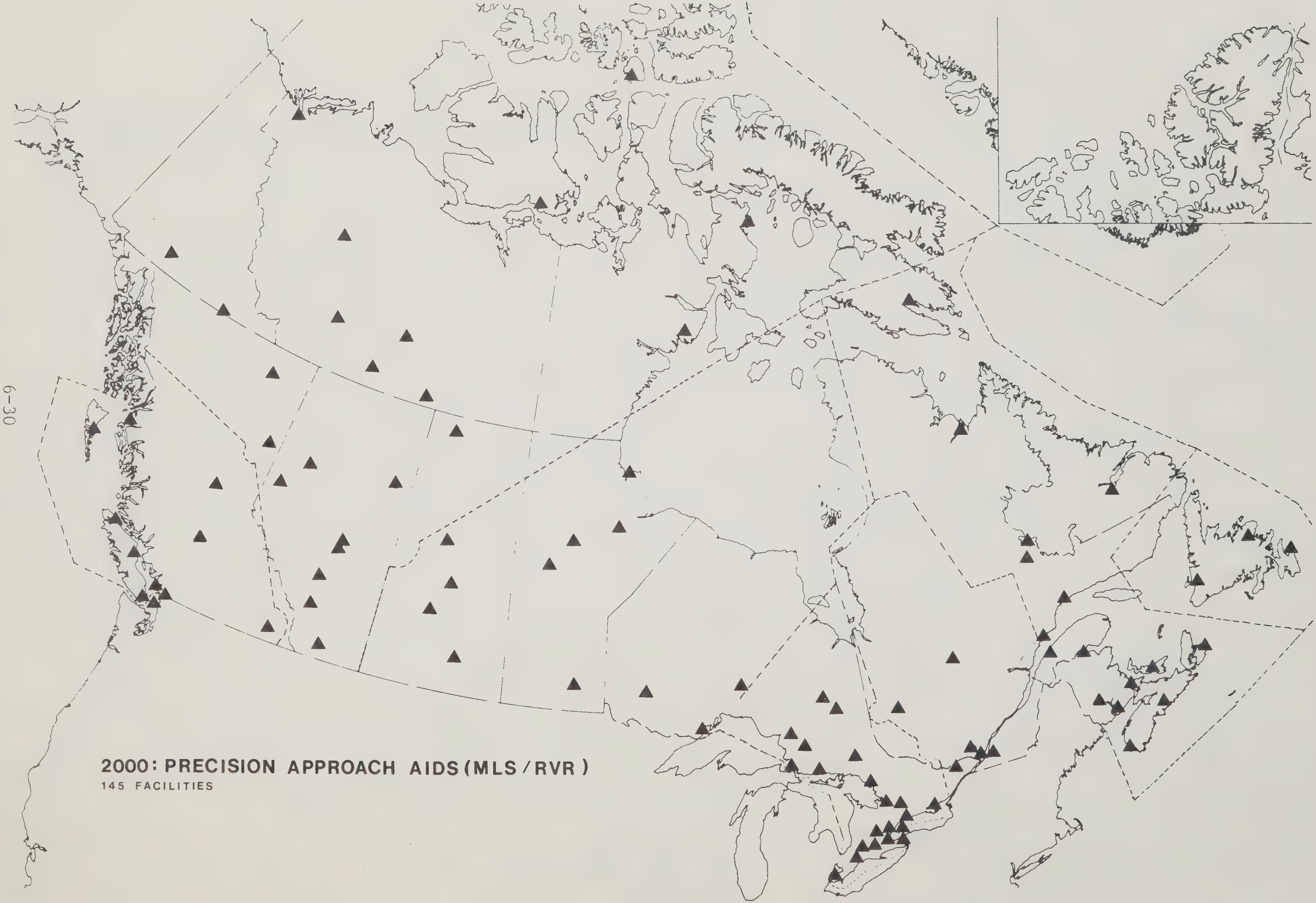


1982: PRECISION APPROACH AIDS (ILS/RVR)

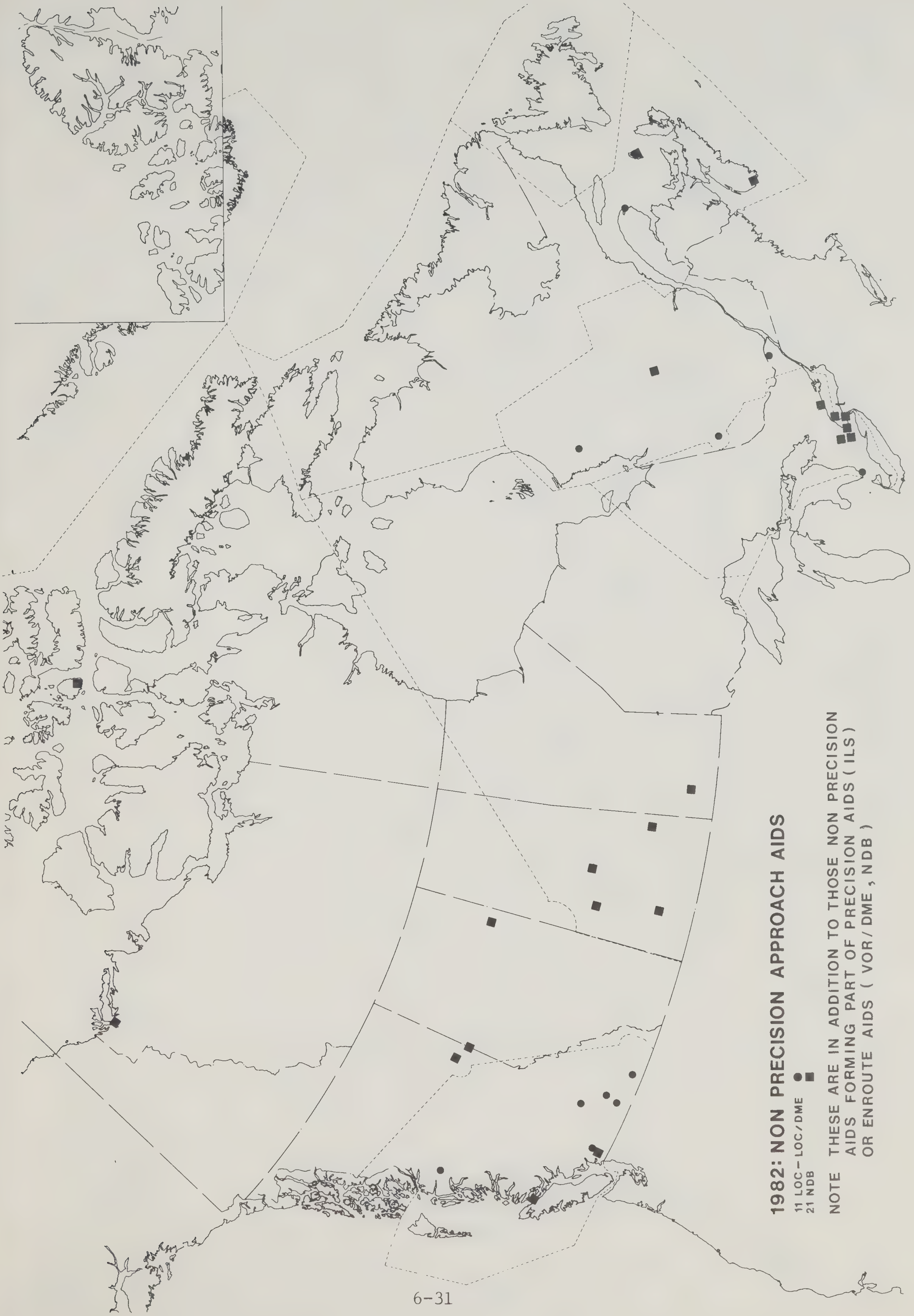
89 FACILITIES

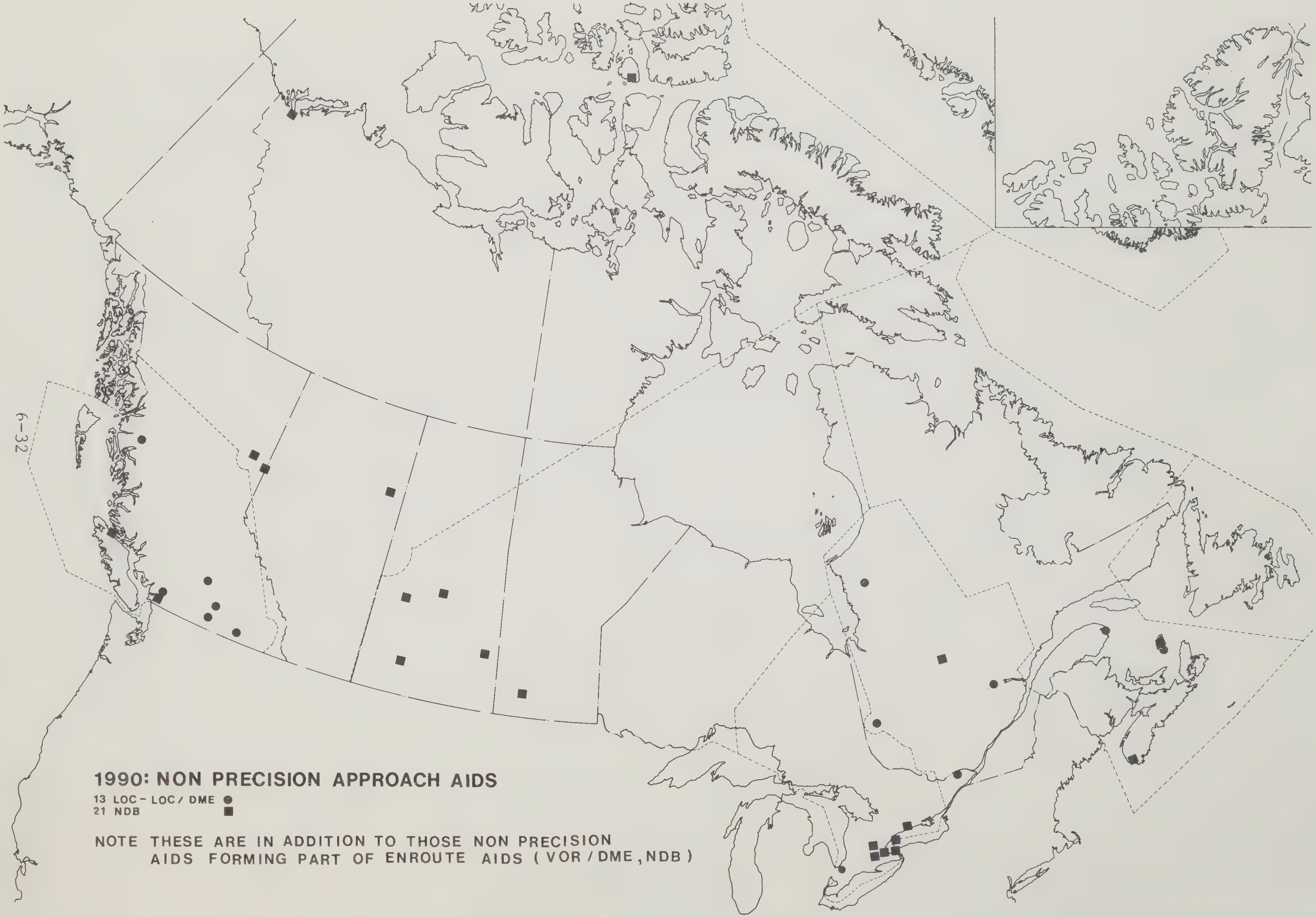


1990: PRECISION APPROACH AIDS (ILS/RVR)
103 FACILITIES

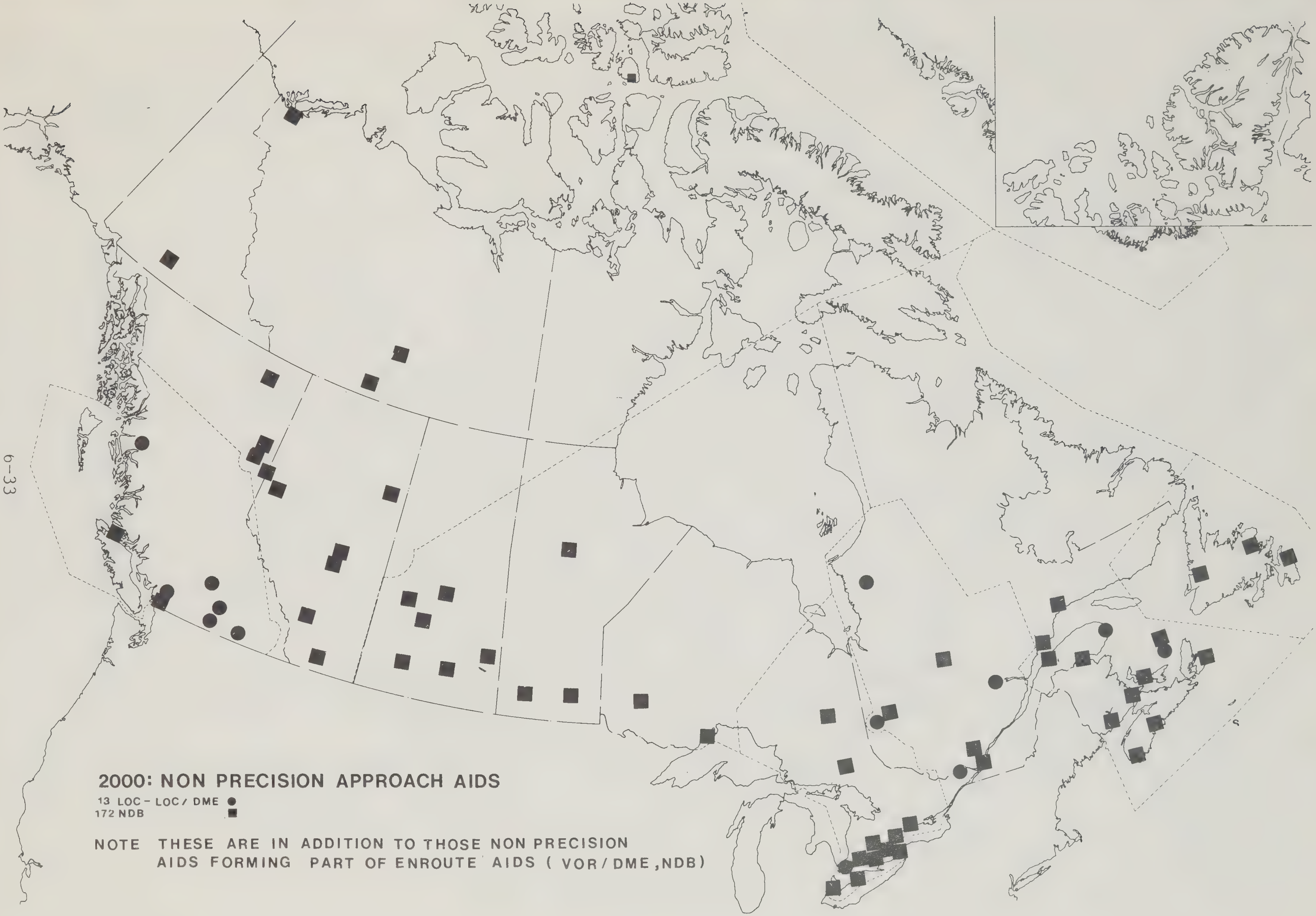


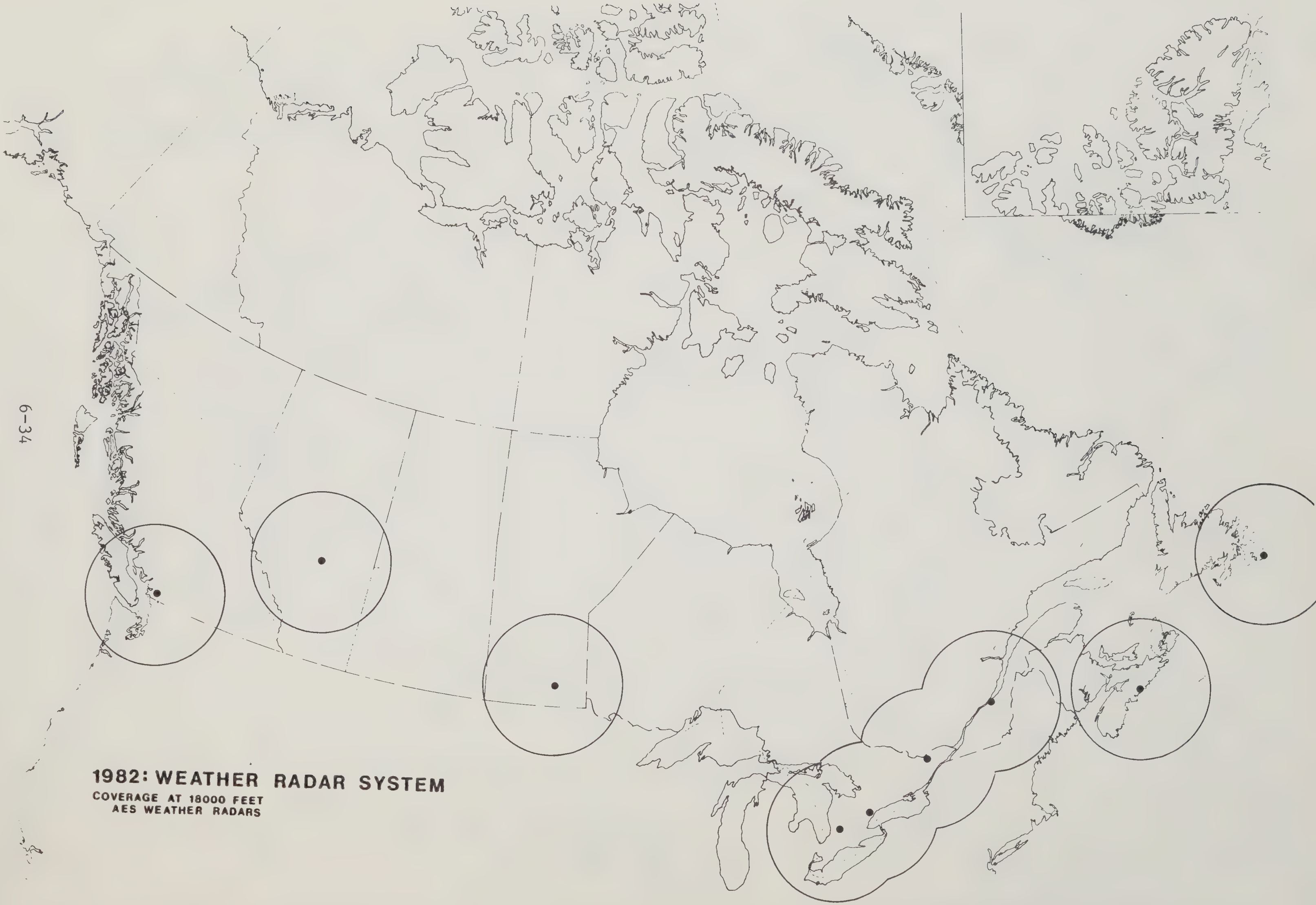
2000: PRECISION APPROACH AIDS (MLS / RVR)
145 FACILITIES


1982: NON PRECISION APPROACH AIDS
11 LOC – LOC/DME ●
21 NDB ■
NOTE THESE ARE IN ADDITION TO THOSE NON PRECISION
AIDS FORMING PART OF PRECISION AIDS (ILS)
OR ENROUTE AIDS (VOR/DME , NDB)



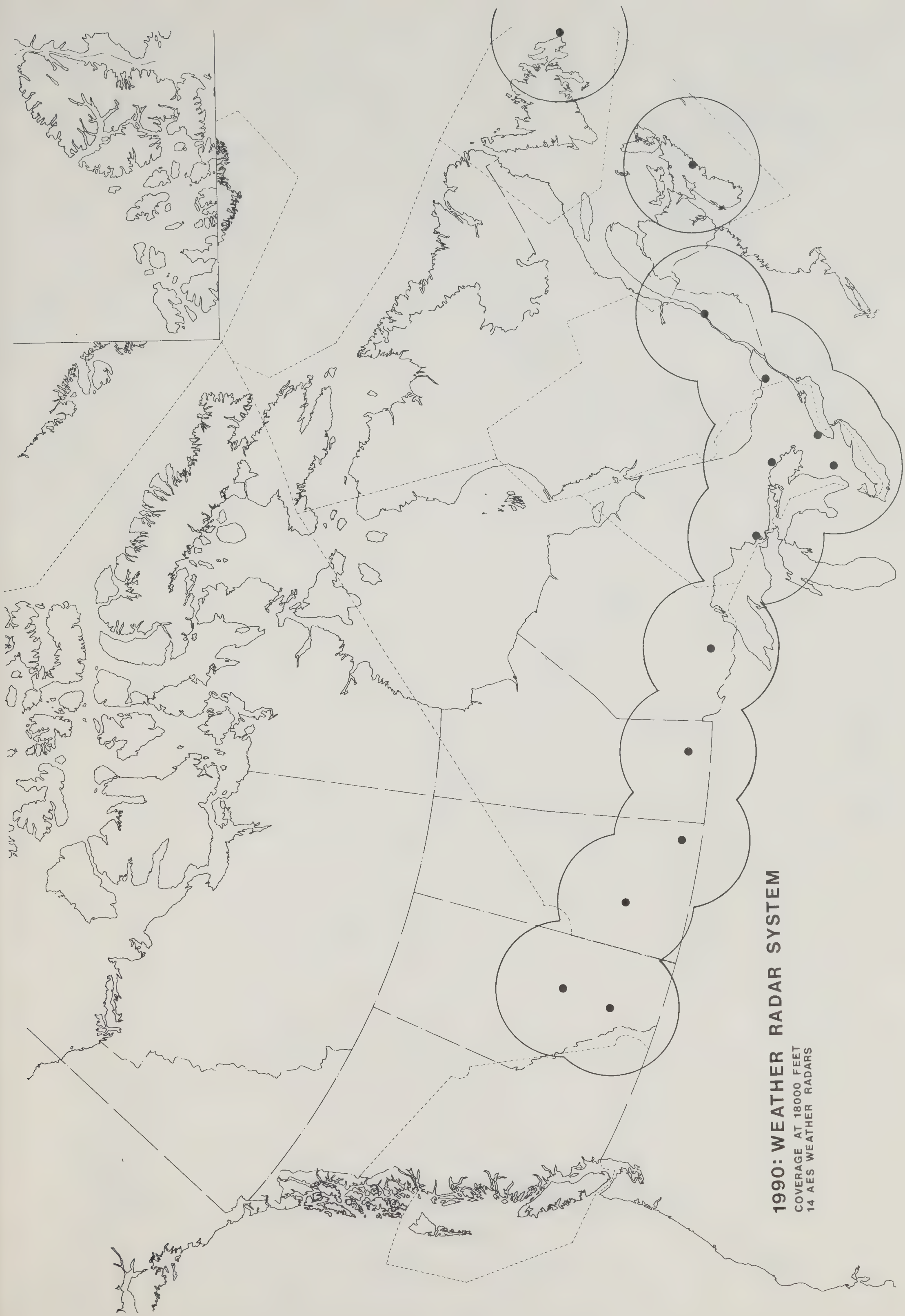
1990: NON PRECISION APPROACH AIDS

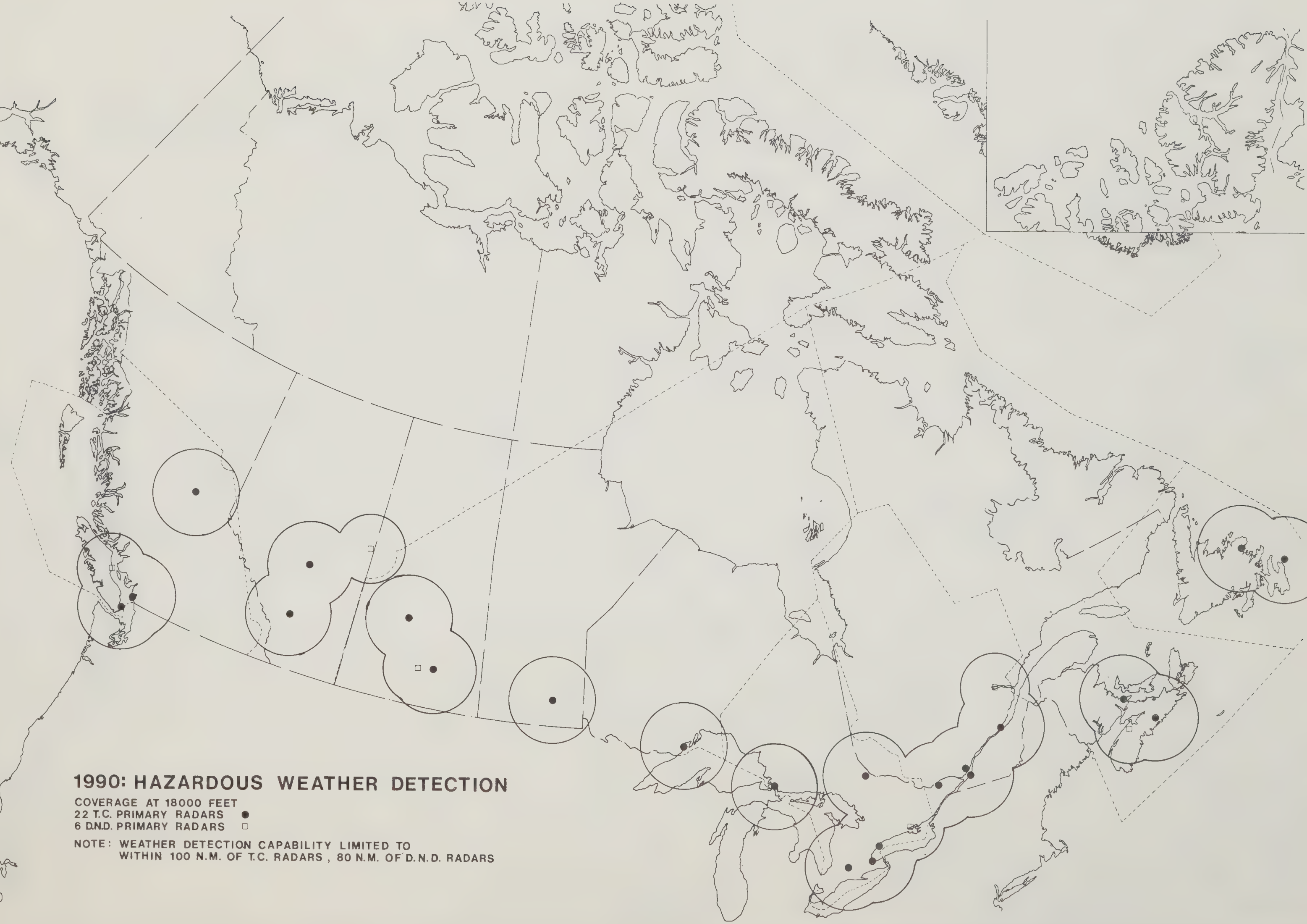

2000: NON PRECISION APPROACH AIDS
13 LOC - LOC / DME
172 NDB
NOTE THESE ARE IN ADDITION TO THOSE NON PRECISION AIDS FORMING PART OF ENROUTE AIDS (VOR / DME ,NDB)

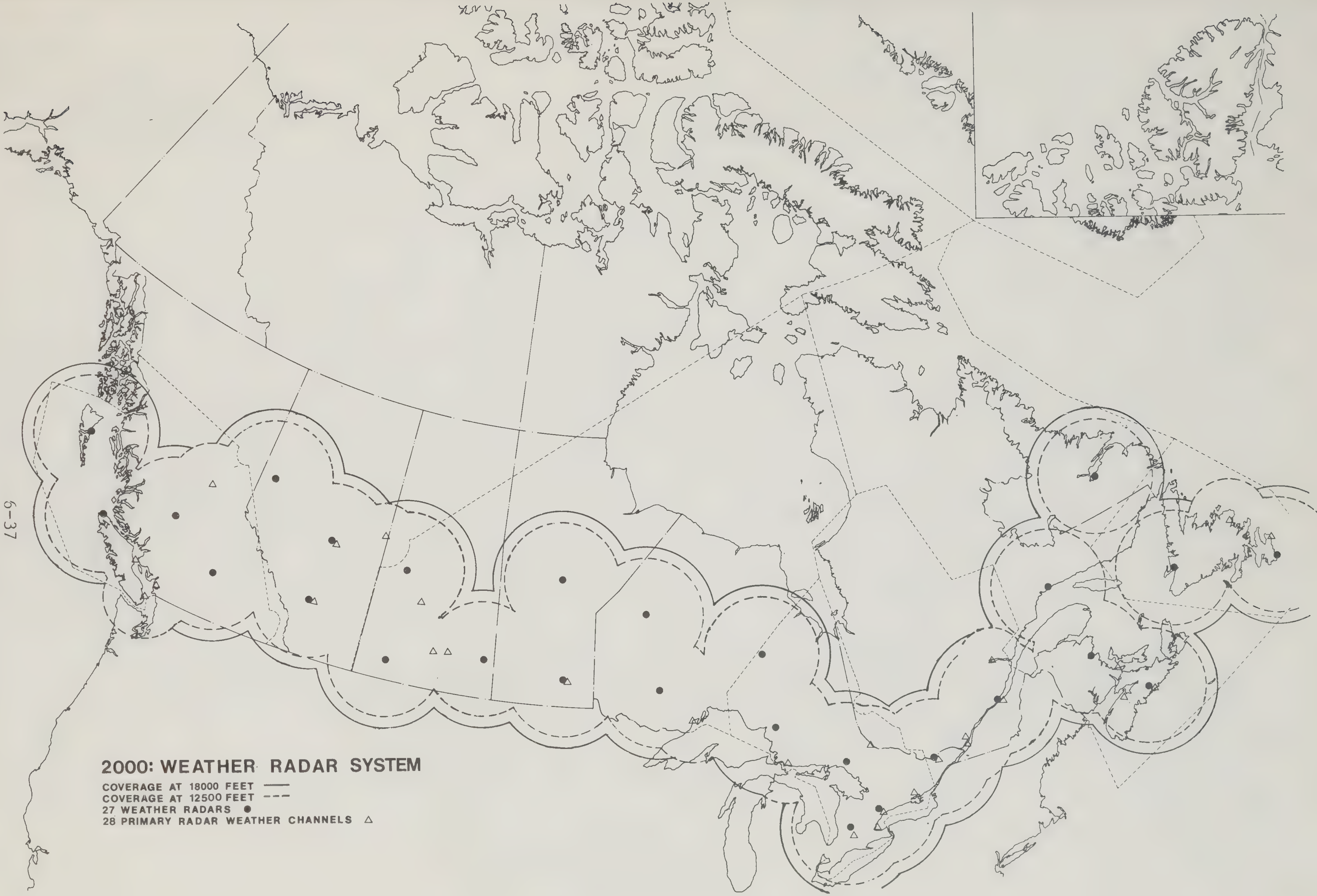


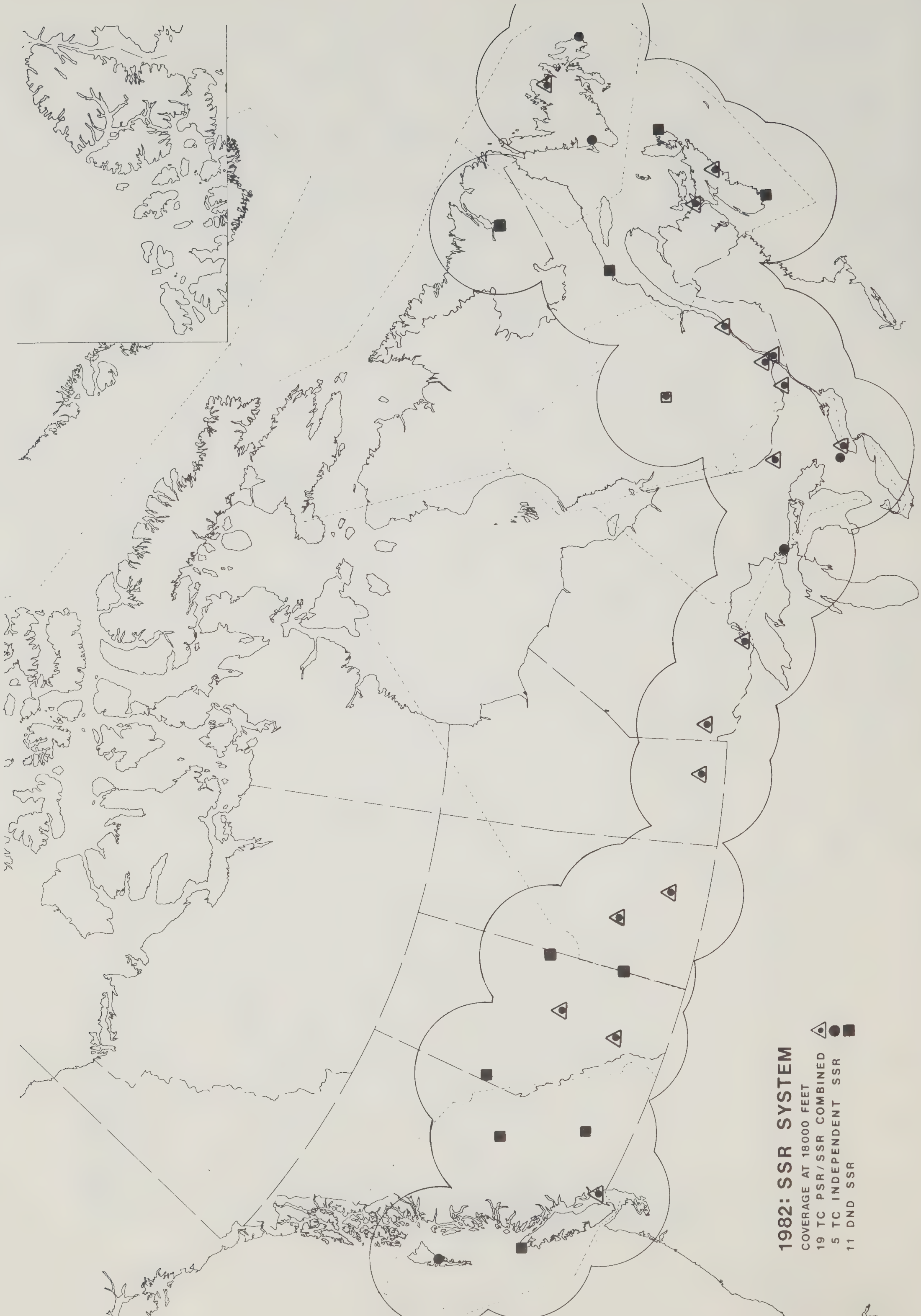
1982: WEATHER RADAR SYSTEM

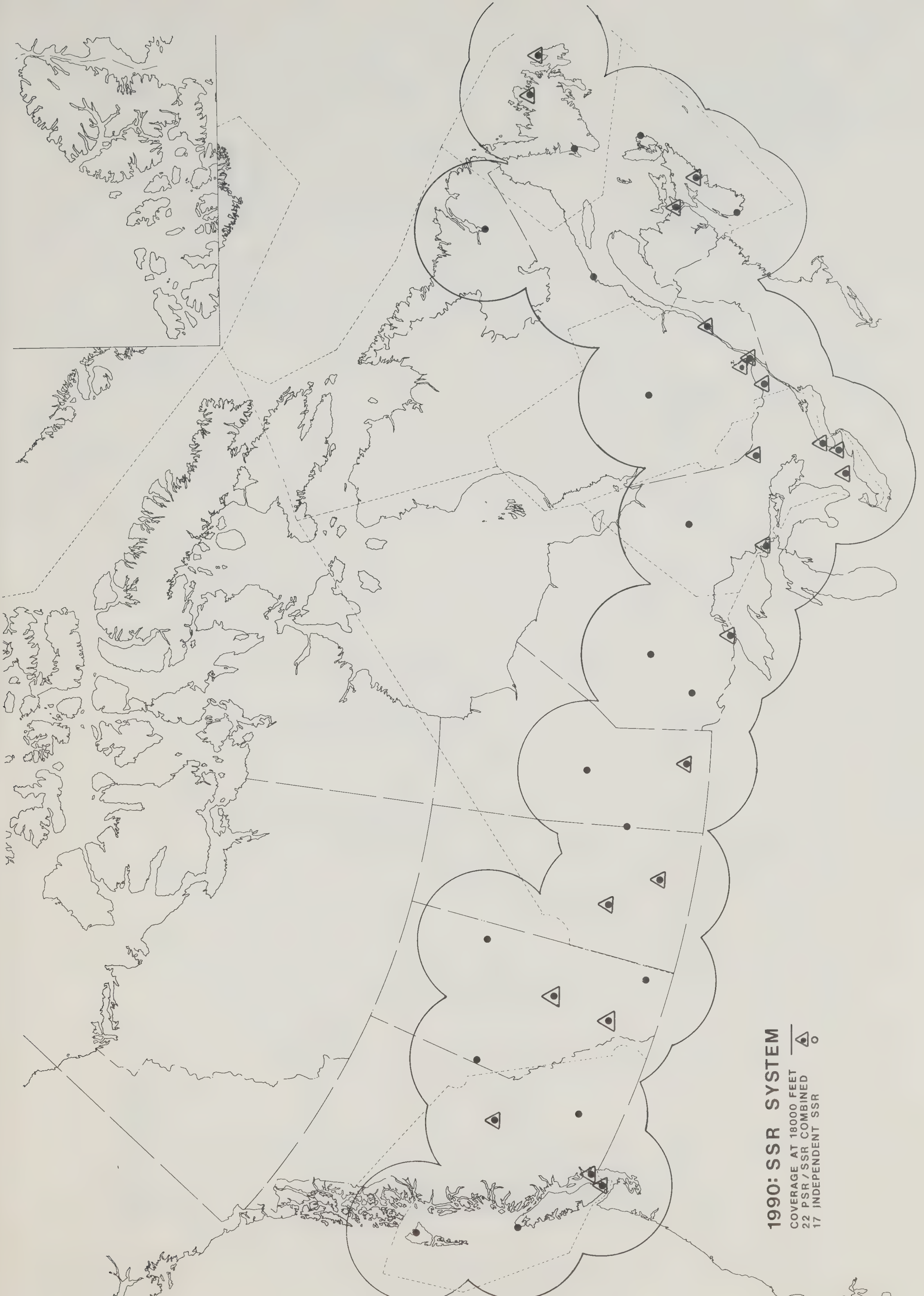
COVERAGE AT 18000 FEET
AES WEATHER RADARS

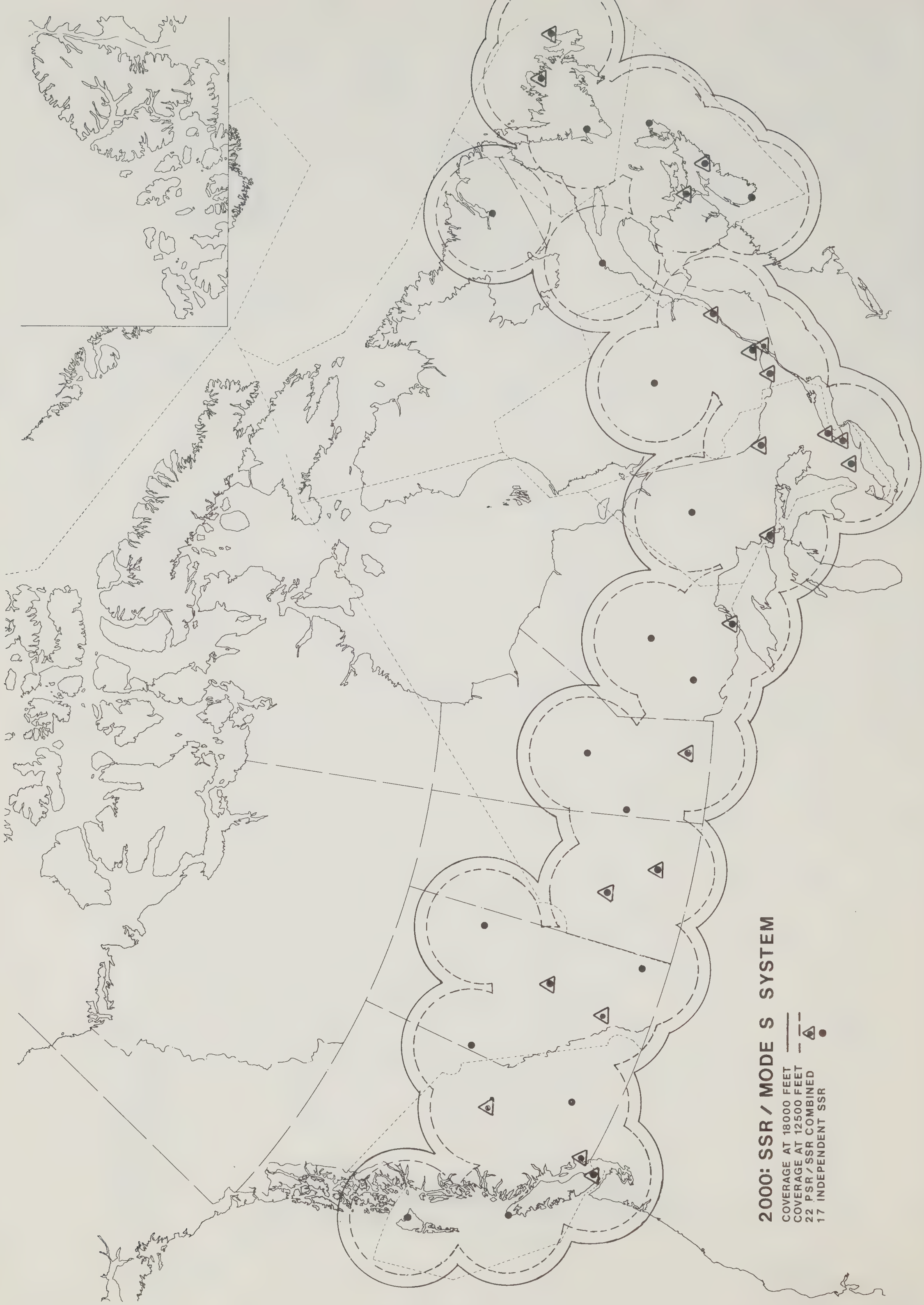

1990: WEATHER RADAR SYSTEM
COVERAGE AT 18000 FEET
14 AES WEATHER RADARS


1990: HAZARDOUS WEATHER DETECTION
COVERAGE AT 18000 FEET
22 T.C. PRIMARY RADARS ●
6 D.N.D. PRIMARY RADARS □
NOTE: WEATHER DETECTION CAPABILITY LIMITED TO WITHIN 100 N.M. OF T.C. RADARS, 80 N.M. OF D.N.D. RADARS


2000: WEATHER RADAR SYSTEM
COVERAGE AT 18000 FEET
COVERAGE AT 12500 FEET
27 WEATHER RADARS
28 PRIMARY RADAR WEATHER CHANNELS


1982: SSR SYSTEM
COVERAGE AT 18000 FEET
19 TC PSR/SSR COMBINED
5 TC INDEPENDENT SSR
11 DND SSR


1990: SSR SYSTEM
COVERAGE AT 18000 FEET
22 PSR/SSR COMBINED
17 INDEPENDENT SSR


2000: SSR / MODE S SYSTEM
COVERAGE AT 18000 FEET
COVERAGE AT 12500 FEET
22 PSR / SSR COMBINED
17 INDEPENDENT SSR

PROGRAM	IMPLEMENTATION 1st	IMPLEMENTATION Last
COMMUNICATIONS		
1. Air Ground VHF Communications	1982	2000
2. Air Ground HF Communications	1983	1989
3. Data Link for Dependent Surveillance	1988	1991
NAVIGATION		
4. VOR/DME/TACAN	1980	2000
5. Non-Directional Beacons	1980	2000
6. VHF/DF	1984	1995
7. VLF Stations	1987	1990
8. Differential Omega	1986	1995
LANDING SYSTEMS		
9. Instrument Landing Systems (ILS)	1980	1987
10. Microwave Landing System (MLS) and Precision DME (DME-P)	1982	2000
11. RVR System	1982	2000
12. Airport Surface Navigation	1990	2000
SURVEILLANCE		
13. Weather Radar	1982	2000
14. Radar Modernization Project (RAMP)	1987	1992
15. Airport Surface Detection Equipment	1984	1988
16. Mode S Data Link	1994	2000
GENERAL		
17. Consolidation of Navigation, Communications and Surveillance Facilities.	1985	2000
18. Satellite derived navigation, communication and surveillance.		

PROJECT: AIR GROUND VHF COMMUNICATIONS

PURPOSE: To replace obsolete VHF communications equipment with highly reliable state-of-the art models capable of operating in a 25 kHz environment. Antennas will be replaced with designs that will provide better coverage patterns and higher isolation. Also, transmitters, receivers, multicouplers and antennas will be provided to meet the expansion of Air Traffic services and for the extension of communication services to remote areas.

Increases in the demand for communication services in air traffic services have generated a requirement for additional channels. This can only be accomplished in the frequency spectrum by decreasing the channel spacing to 25 kHz. This channel spacing cannot be done economically with the older equipment.

The higher reliability associated with modern equipment makes it possible to reduce the requirement for periodic maintenance resulting in a savings of 40 hours per year for each transmitter and receiver pair.

A reduction in power consumption will also result by the conversion to more efficient equipment. It is estimated that 2.0 megawatt-hours per year will be saved by each transmitter/receiver pair.

APPROACH: The project is planned on a multi-year procurement basis in three phases

Phase I: Replace remote communications equipment.
Phase II: Replace communications equipment at TWR's, TCU's and ACC's
Phase III: Replace communications equipment at FSS's.

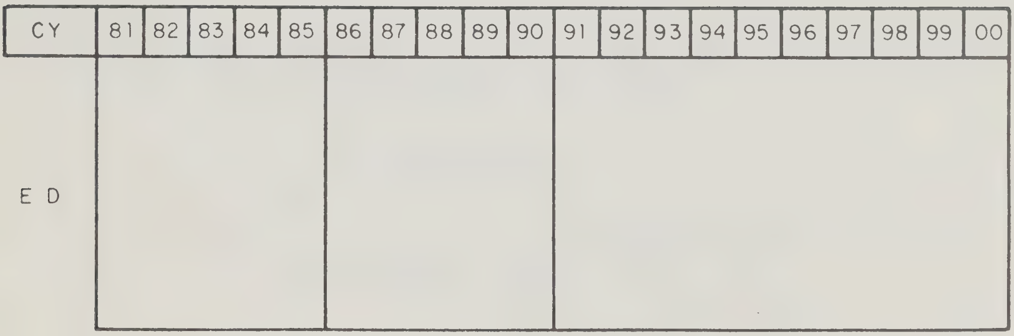
QUANTITIES:

	Replacement	New
By 1982	450 Transmitters 325 Receivers 300 Dual Antennas	50 Transmitters 50 Receivers 50 Antennas 50 Multicouplers
By 1985	580 Transmitters 460 Receivers 200 Dual Antennas	340 Transmitters 340 Receivers 150 Antennas 140 Multicouplers
By 1990	310 Transmitters 560 Receivers 200 Dual Antennas	140 Transmitters 140 Receivers 100 Dual Antennas 50 Multicouplers

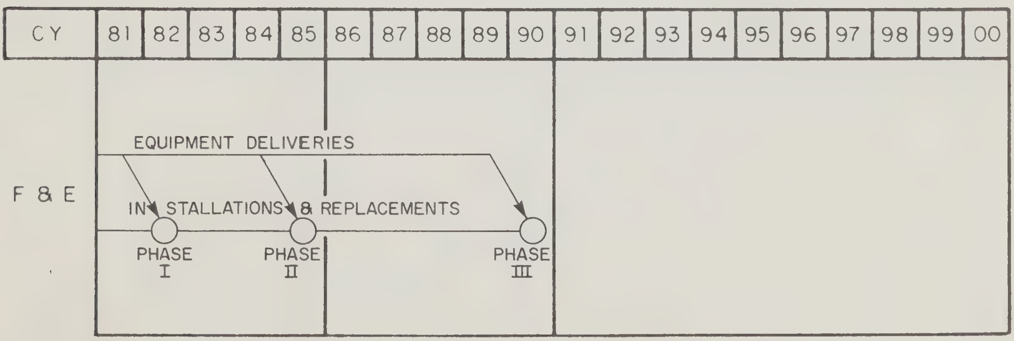
RELATED PROJECTS/ACTIVITIES:

- Consolidation of Navigation, Communication and Surveillance facilities.

SCHEDULE



SCHEDULE



PROJECT: AIR GROUND HF COMMUNICATIONS

PURPOSE: To replace obsolete tube-type transmitters and receivers with more reliable, efficient solid-state equipment. This equipment is used principally on the 5680 kHz service available at northern Flight Service Stations to provide communications with aircraft operating beyond the VHF range in the low density traffic area. Some equipment is also required to provide ICAO service for International air ground communications and to provide for grd - grd links.

Existing equipment exhibits poor availability, high energy utilization and high maintenance costs. It also fails to meet international frequency stability requirements. The new units will decrease maintenance and engergy costs by at least 50%.

APPROACH: The project is planned on a multi-year procurement basis. The first phase will replace the international air-ground equipment by 1985 while the second will replace 5680 kHz equipment by 1989.

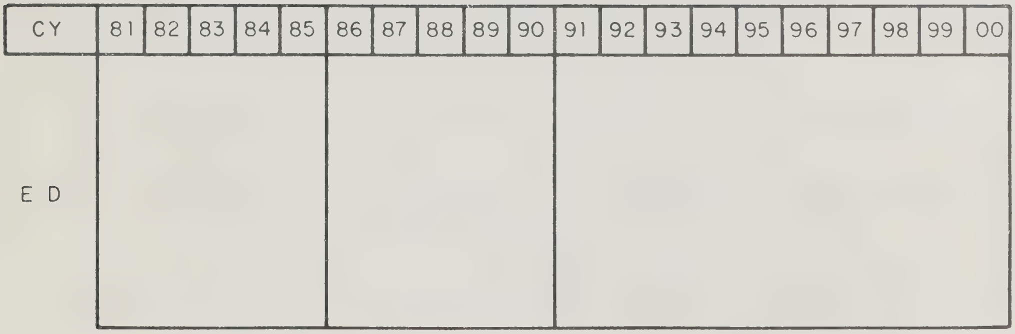
QUANTITIES: The planned replacement schedule is as follows.

By	1982/83	18 Transmitters
By	1984/85	32 Transmitters 41 Receivers
By	1985/86	30 Transmitters 40 Receivers
By	1986/87	30 Transmitters 40 Receivers

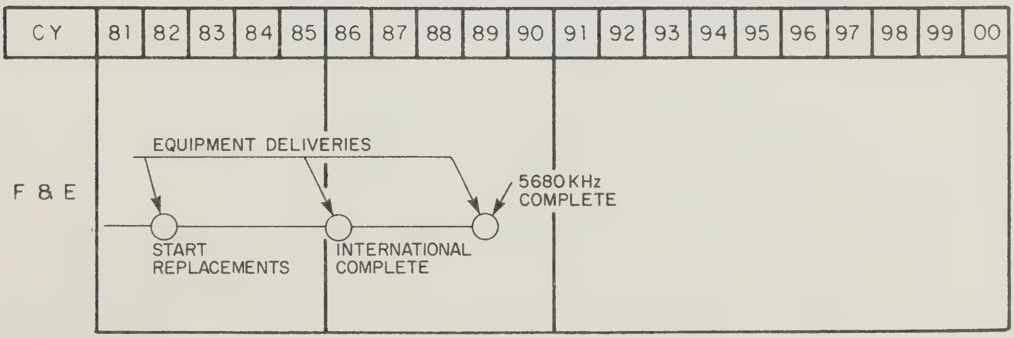
RELATED PROJECTS/ACTIVITIES:

- Data Link for Dependent Surveillance.

SCHEDULE



SCHEDULE



PROJECT: DATA LINK FOR DEPENDENT SURVEILLANCE

PURPOSE: To provide a dependent surveillance capability, an exchange of weather data to and from the aircraft and transfer of clearances and flight plans on all suitably equiped aircraft operating in the low density traffic area and in the oceanic area.

In support of reducing operator costs and improved airspace utilization, ATC management of traffic flows in the low density traffic area requires accurate, timely surveillance data. Because of the vast volume of airspace to be covered, traditional surveillance techniques (radar) are far too costly. The transfer of aircraft positional data, derived from their navigational systems will provide the improved surveillance data for ATC, and permit direct, fuel efficient, conflict free routings for users of the airspace. The data link exchange of weather information, clearances, and flight plans will also result in more efficient operation.

APPROACH: Beginning in 1983, enginering development work will begin to explore avionics capabilities and accuracies, communications techniques and update rates and overall cost projection. Feasibility projects, in conjunction with airlines will be conducted. Operational tests of the chosen system(s) will begin in 1987, with a target date of 1992 for first implementation.

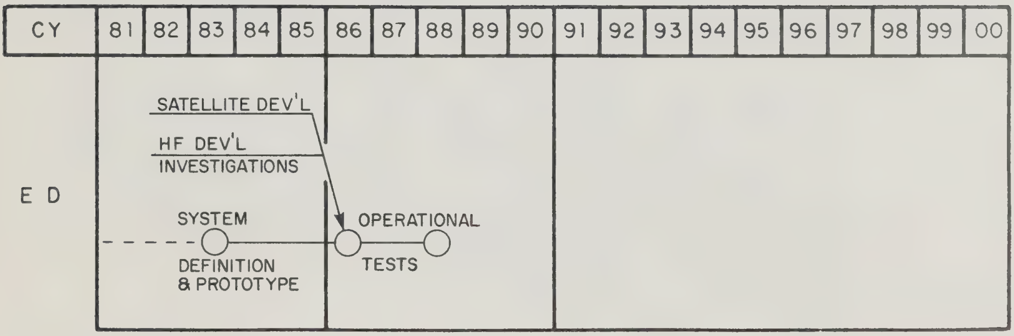
Satellite and HF techniques will be explored for data link communications.

QUANTITIES: To be determined.

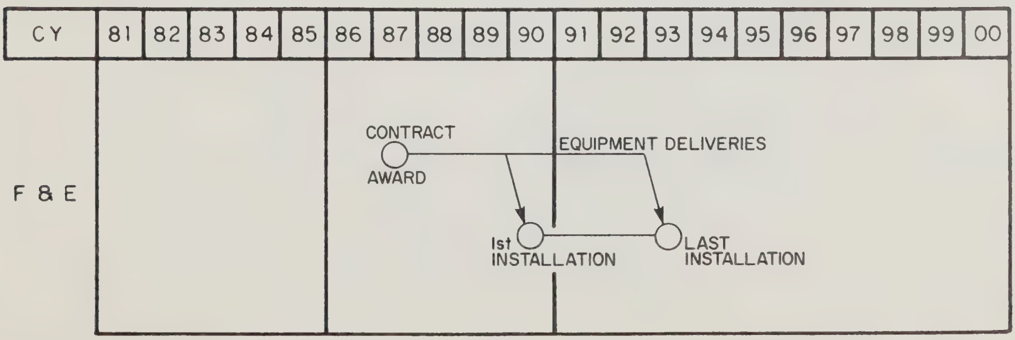
RELATED PROJECTS/ACTIVITIES:

- Flight Data Processing System
- VOR - DME - TACAN
- Air-Ground HF Communications
- Satellite based Surveillance, Communications and Navigation
- Advanced Integrated ATC System
- Canadian Aeronautical Digital Network

SCHEDULE



SCHEDULE



PROJECT: VOR-DME-TACAN

PURPOSE: To provide for new and replacement VOR, DME and TACAN systems. VOR and DME are used for enroute airway navigation, to provide navigation data to airborne area navigation systems and, in some cases, as approach aids. TACAN is a system used as a VOR-DME equivalent by the military and to provide DME information for civil aircraft from colocated VOR/TACANS.

APPROACH: Replacements - There are 51 VOR systems remaining to be replaced with solid state equipment during the period 1982-1988. A program will be established with DND to replace 32 collocated TACAN's between 1985 and 1990. No DME's will be replaced since all existing systems are currently solid state.

New requirements - Additional VOR-DME's will continue to be installed both for airway and area navigation in the high density traffic area and will eventually enable aircraft to operate on fuel efficient random routes. Expansion of the VOR-DME system will continue at a rate of 3 to 6 systems per year until 1995. DME's will be established at NDB's in the low density traffic area to provide for updating suitably equipped INS aircraft.

Relocations - Due to performance decline, route structure changes or real estate considerations it becomes necessary to convert standard VOR to Doppler VOR or to relocate facilities from time to time.

Upgrades - The new VOR, DME and TACAN equipment which will be procured after 1985 will incorporate full remote maintenance monitoring capability. Retrofit programs will be established to incorporate remote maintenance monitoring techniques into equipments procured prior to 1985. The incorporation of continuous weather broadcasts on VOR will be carried out in conjunction with investigation of the desirability of utilizing voice identification.

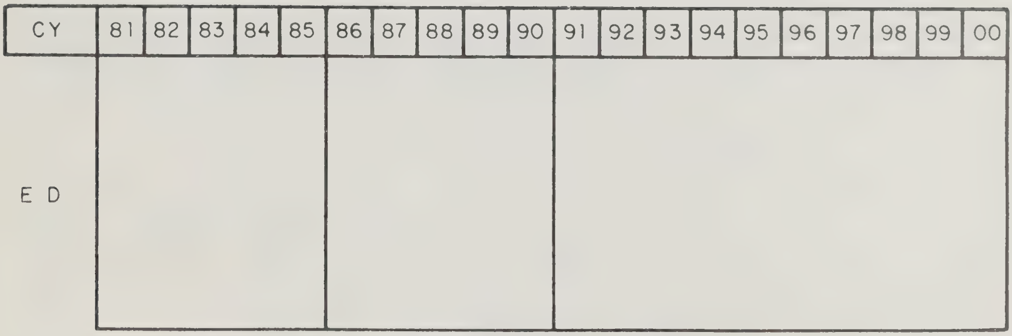
QUANTITIES:

		1982-85	1986-1990	1991-2000
Replace SVOR		20	30	
Replace DVOR		3		
Replace TACAN			32	
Retrofit VOR/DME RMM			50	50
Establish new SVOR/DVOR		12	20	20
Establish DME in MNPS			16	
Replace & Establish VOT		20	10	15
Disaster Replace	VOR/DME	1	1	1
	VOT	1	1	1
	VORTAC	1	1	1

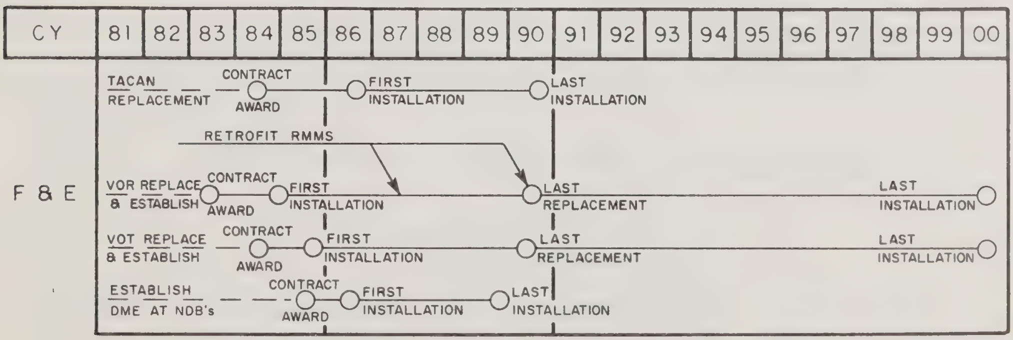
RELATED PROJECTS/ACTIVITIES:

- Consolidation of surveillance, communications and navigation
- FSS Workstation
- Remote Maintenance Monitoring System
- Automatic Weather Observation and Reporting System.

SCHEDULE



SCHEDULE



PROJECT: NON-DIRECTIONAL BEACONS

PURPOSE: To provide for the extension of the route structure to locations not presently served and to provide additional airports with non-precision approach guidance expansion of the NDB system is required. The non-directional beacon (NDB) is a low/medium frequency facility that transmits omnidirectional signals whereby the aircraft pilot can determine his bearing and "home" in on the station. NDB's are used as navigation fixes defining air routes, as non-precision approach systems and as compass locators for precision landing systems. About half of the existing NDB installations require replacement with solid state equipment. The addition of remote maintenance monitoring and continuous weather broadcast will be required at both existing and new NDB sites.

APPROACH: Establish, replace, retrofit and colocate with other facilities to provide solid state equipment with remote maintenance monitoring capability.

QUANTITIES:

	1982-85	1985-90	1990-2000
Establish NDB's - Enroute	20	15	-
NDB's - Approach	15	15	30
Replace NDB's - Enroute	40	20	-
- Approach	40	20	-
Retrofit NDB with RMM - All			

	1982	1985	1990	2000
NDB's (Enroute & Approach)	393	428	458	488

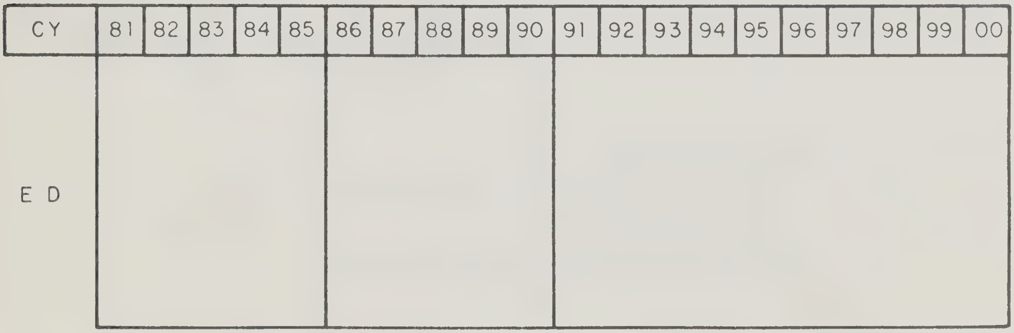
The following assumptions have been made:

- Zero growth of enroute NDB's will occur between 1990 and 2000.
- NDB's associated with ILS will be retained for non-precision approach when MLS is installed.
- Quantities to be confirmed

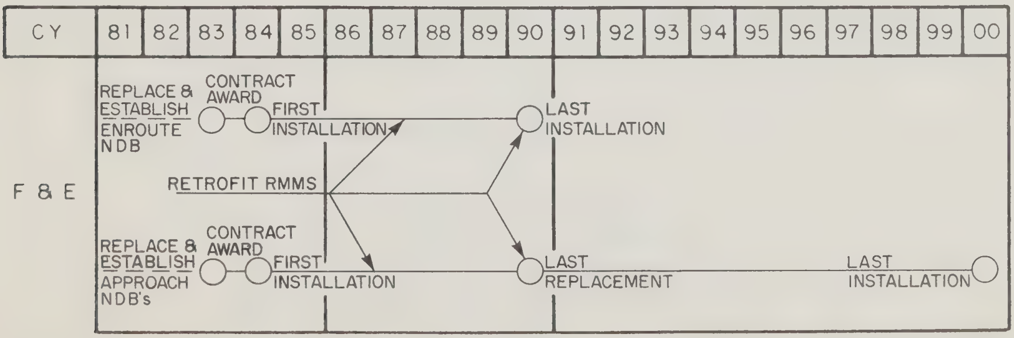
RELATED PROJECTS/ACTIVITIES:

- Differential Omega
- Instrument Landing System
- Microwave Landing System
- VOR-DME - TACAN
- Remote Maintenance Monitoring System.

SCHEDULE



SCHEDULE



PROJECT: VHF-DF

PURPOSE: To expand the VHF-DF coverage in order to provide assistance to pilots experiencing navigational difficulty and for aircraft identification and control purposes. It will incorporate DF bearing and or fixes information with the radar data processing systems and FSS workstation. The application of remote maintenance monitoring will be incorporated. Some relocation will be carried out to consolidate VHF-DF sites with other facilities.

APPROACH: The existing coverage provided by terminal VHF-DF's will be expanded by additional systems and by suitably located enroute systems. Output bearing data from DF's will be correlated in order to establish aircraft fixes where overlapping coverage by two or more DF's is available. Remote maintenance monitoring will be retrofitted into all existing and future installations.

QUANTITIES:

	1981-85	1985-1990	1990-2000
Establish DF	15	25	-
Colocate DF	-	10	30
Retrofit with RMM	-	70	-

	1982	1985	1990	2000
VHF/DF	78	93	118	-

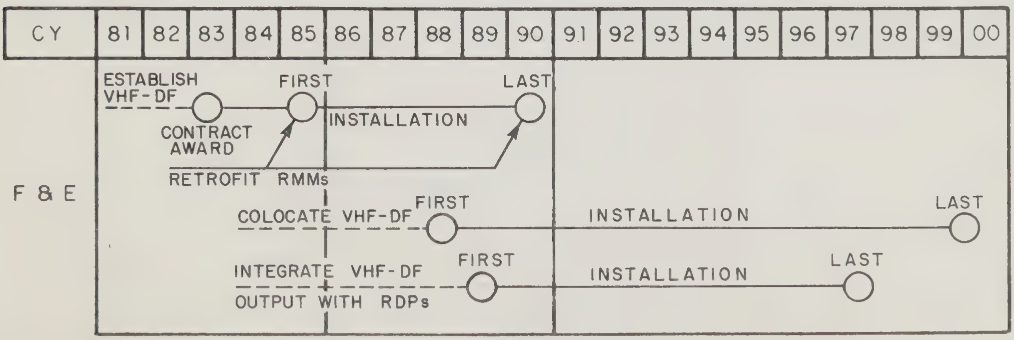
RELATED PROJECTS/ACTIVIVITIES:

- Remote Maintenance Monitoring System
- FSS Workstation
- Radar Data Processing System
- Canadian Aeronautical Digital Network

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE



PROJECT: VLF STATIONS

PURPOSE: To provide enhanced Omega navigation coverage and accuracy in Canada and in particular in the low density traffic area. The worldwide coverage provided by Omega is not adequate in North Central Canada due to propagation and geometry constraints. Consideration is being given to supplement this with dedicated VLF stations in order to provide a reliable low cost wide area navigation system.

APPROACH: A feasibility study will be conducted to determine the minimum cost solution in terms of the number of stations required, power and coverage volume, location etc. When approved, contracts will be awarded for the design, equipment fabrication and installation of the required station(s).

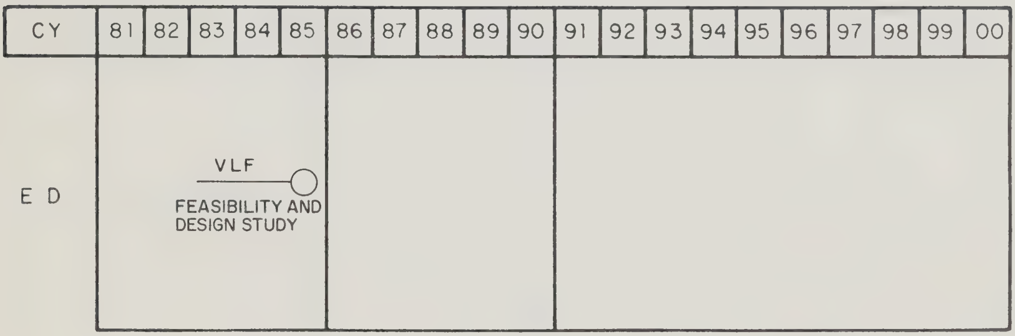
QUANTITIES:

	1982-85	1985-90	1990-2000
VLF Stations	-	1 or 2	-

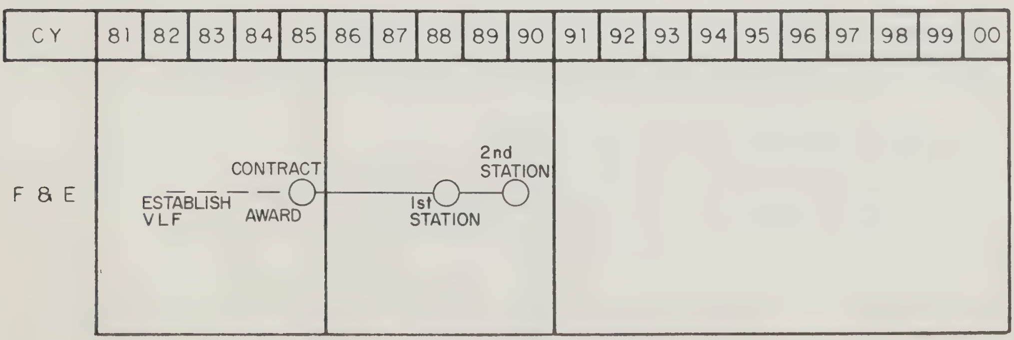
RELATED PROJECTS/ACTIVITIES:

- Differential Omega.
- Remote Maintenance Monitoring System

SCHEDULE



SCHEDULE



PROJECT: DIFFERENTIAL OMEGA

PURPOSE: To develop the design and the equipment required to provide an enhanced Omega accuracy within 150 nm. of selected NDB locations through the use of differential techniques. The NDB is used to transmit the differential correction data to the aircraft which in turn applies the correction data to the received Omega signals.

APPROACH: Existing engineering development work will continue to refine and demonstrate the capabilities of Differential Omega. When approved, contracts will be awarded for the procurement of suitable ground equipment and airborne equipment manufactures will be encouraged to produce the necessary airborne components. Installations will then be carried out at selected locations in consultation with the aviation community.

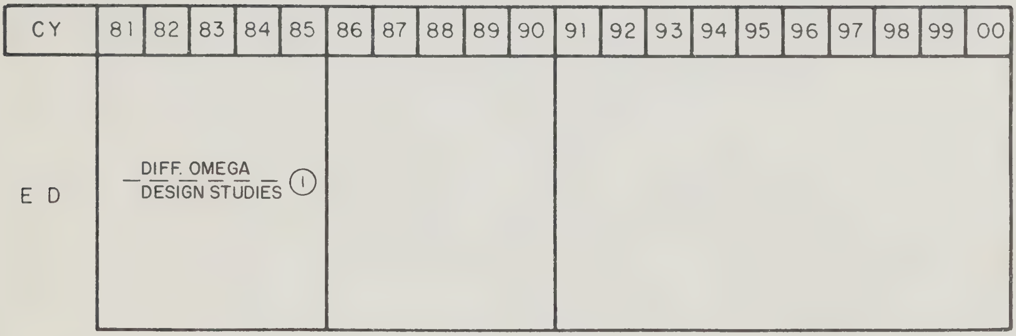
QUANTITIES:

	1982-85	1985-90	1990-2000
Establish Differential Omega	-	5	21

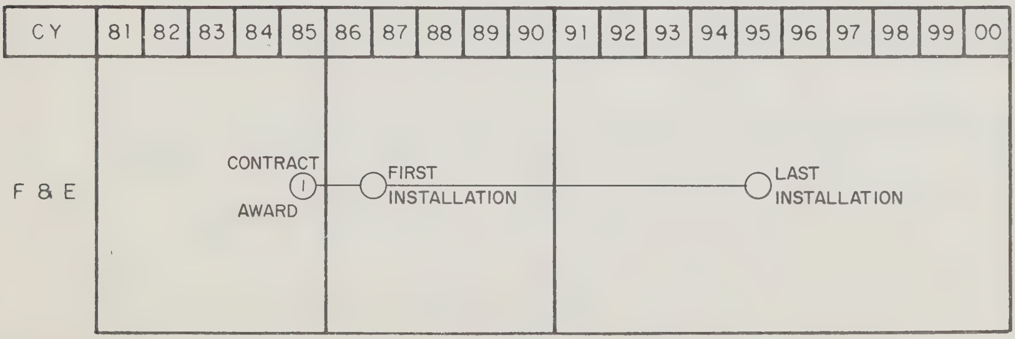
RELATED PROJECTS/ACTIVITES:

- Non Directional Beacons
- VOR - DME - TACAN
- VLF Stations

SCHEDULE



SCHEDULE



PROJECT: INSTRUMENT LANDING SYSTEM - ILS

PURPOSE: To complete the ILS replacement program and to establish new ILS installations. This project will also involve the incorporation of remote maintenance monitoring into existing ILS equipment.

APPROACH: Contracts will be issued for equipment to replace existing tube type equipment and to satisfy the establishment of new ILS at selected locations. The remote maintenance monitoring requirements for ILS will be established and retrofit of these systems will be carried out. Due to the 1995 protection date for ILS and the planned withdrawal of these systems by 2000, the last new ILS is expected to be established in 1987. Beyond that date the installation of MLS will be preferred.

QUANTITIES:

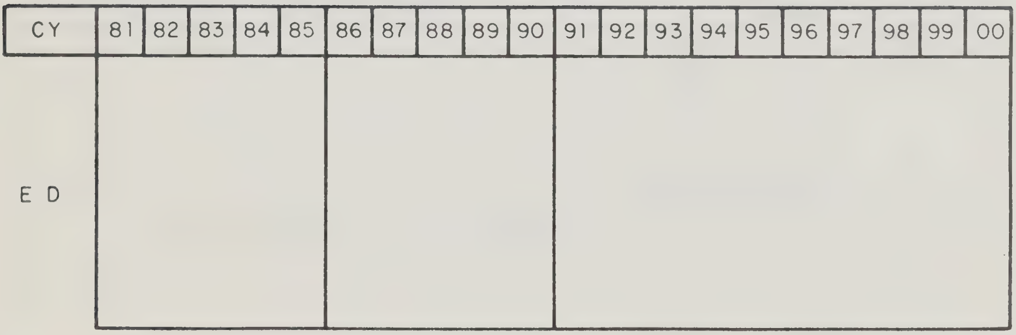
	1982-85	1985-90	1990-2000
Replace ILS	15	20	-
Establish ILS	5	10	-
Retrofit ILS with RMMS	-	102	-

	1982	1985	1990	2000
No. of ILS	87	92	103	-

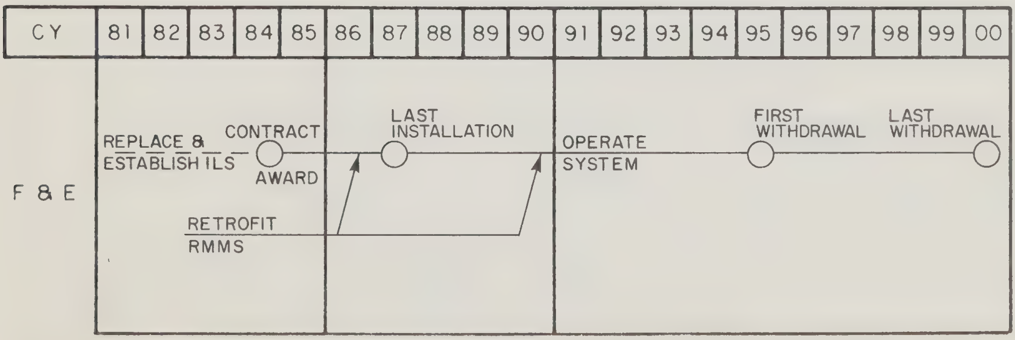
RELATED PROJECTS/ACTIVITES:

- Microwave Landing System
- Remote Maintenance Monitoring System.

SCHEDULE



SCHEDULE



PROJECT: MICROWAVE LANDING SYSTEM (MLS) AND PRECISION DISTANCE MEASURING EQUIPMENT (DME-P).

PURPOSE: To implement a transition from the current instrument landing system to the new international standard MLS incorporating a new more precise distance measuring equipment. The international protection date for the current system is 1995. MLS installations will have to be carried out over the period 1986 - 1995 so that Canada will be in a position to withdraw ILS from service after 1995. This project also provides for normal expected growth in precision landing system to the year 2000 and implementation of category III at selected airports.

APPROACH: MLS will be installed in parallel with the current system between 1986 and 1995. After 1987 airports requiring new precision approach equipment will be provided with MLS rather than ILS.

The initial testing of MLS will be carried out under an existing test program until 1984 at which time a specification for future MLS procurement will be finalized. Development of DME-P will occur and be integrated with the MLS system.

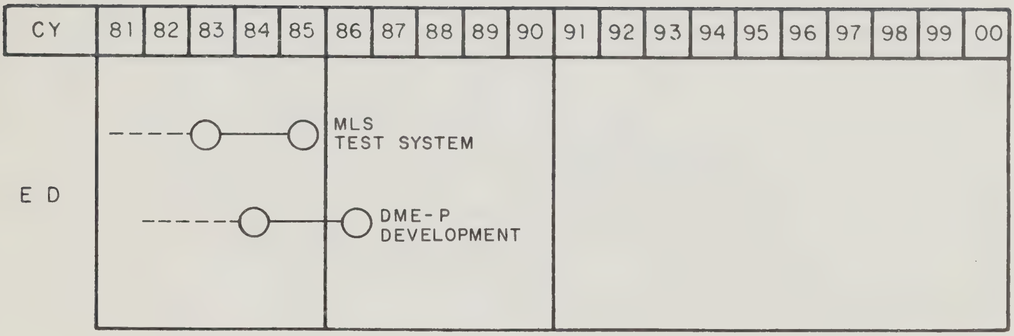
Three major purchases of MLS are expected betweeen 1984 and 2000.

QUANTITIES: 1981 - 1985 - 5
1985 - 1990 - 40
1990 - 2000 - 105

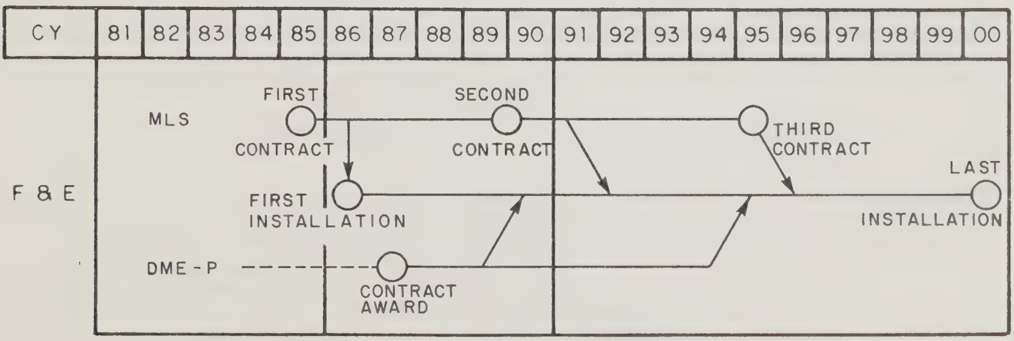
RELATED PROJECTS/ACTIVITIES:

- Instrument Landing System.

SCHEDULE



SCHEDULE



PROJECT: RVR SYSTEMS

PURPOSE: To convert existing RVR systems to solid state technology and to provide RVR for new precision approach systems and at take-off points along designated runways.

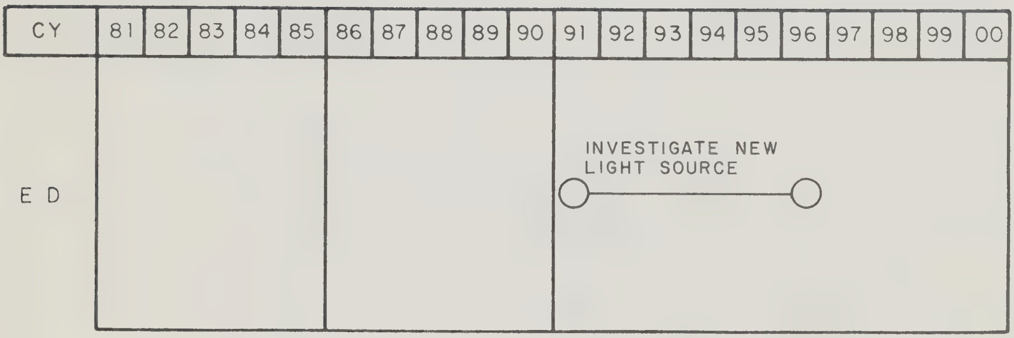
APPROACH: Initially, new solid state transmissometers will replace existing units. New RVR computer design with remote maintenance monitoring features will be incorporated in existing and new installations beginning in 1984. Contracts will be issued to industry for both transmissometer and RVR computer production. Engineering development into new improved sources of light for the transmissometer will be carried out toward the latter part of the period.

QUANTITIES: To be determined.

RELATED PROJECTS/ACTIVITIES:

- Instrument Landing System
- Microwave Landing System
- Automatic Weather Observation and Reporting System.

SCHEDULE



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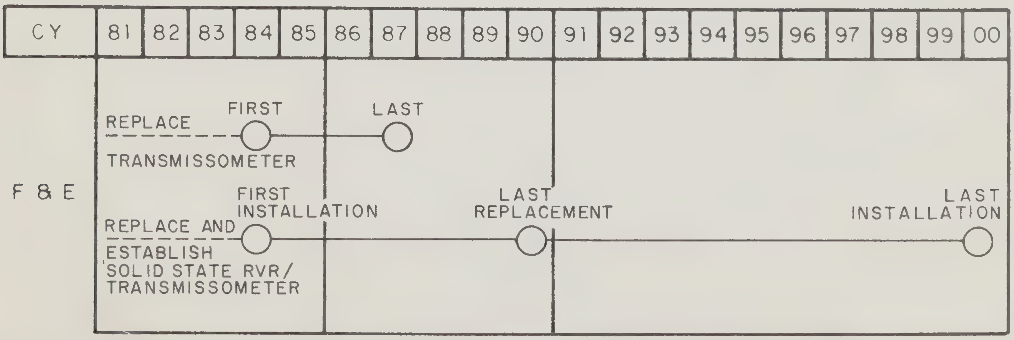


PROJECT: AIRPORT SURFACE NAVIGATION

PURPOSE: To provide an independent accurate surface navigation system permitting aircraft and ground vehicle to navigate on the manoeuvring area of the airport during low visibility conditions without visual reference to the ground. To fully exploit the benefits of category III installations for landing under zero visibility conditions it will be necessary to have the capability of deploying fire, rescue and snow vehicles as well as providing aircraft navigation information under these conditions.

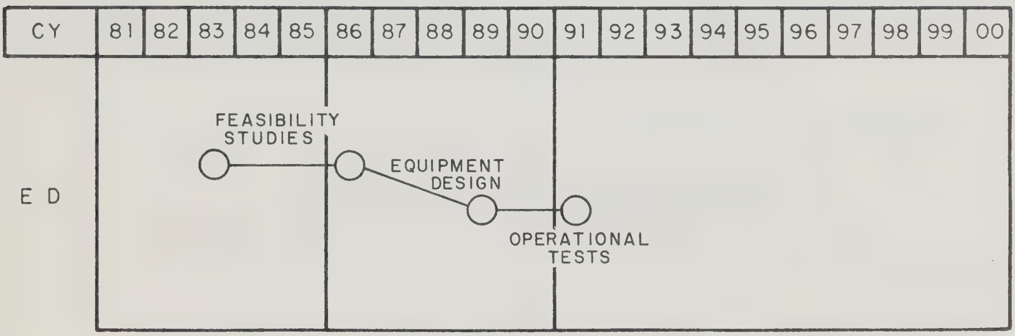
APPROACH: Engineering development will be carried out to test and demonstrate feasibility of a proposed system. When approved, contracts will be issued and installations carried out in conformity with category III precision approach facilities. On-board equipment requirements will be considered as part of the system development.

QUANTITIES: To be determined.

RELATED PROJECTS/ACTIVITIES:

- Instrument Landing System
- Microwave Landing System

SCHEDULE



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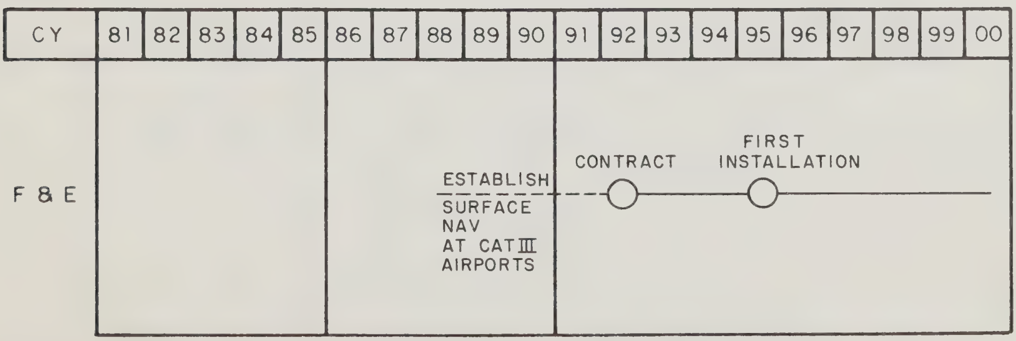


PROJECT: WEATHER RADAR

PURPOSE: To establish an aviation weather radar network that will provide timely and accurate aviation weather data for dissemination to ATS and aviation users.

Real time information on hazardous weather relative to flight is presently neither adequate nor readily available. Limited and unreliable information leads to unexpected or uncoordinated traffic diversions, fuel inefficient routings, and can result in unsafe flight conditions. In addition to improvements to be gained, future automated ATC functions such as flow management, conflict prediction and advanced integration of the ATC system will require reliable and accurate real time weather data.

APPROACH: Coverage will be provided by Atmospheric Environment Services and transport Canada weather radars, the weather radar channels from RAMP primary radars and DND ATC radars, and possibly adjoining U.S. weather radar systems.

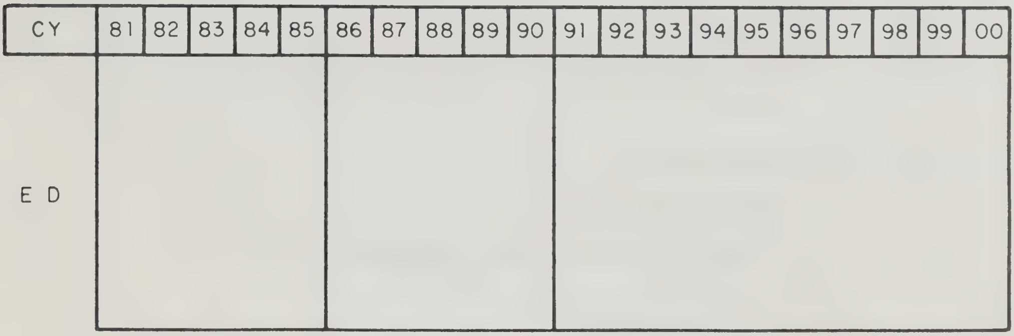
By the year 2000 the combined network of weather radar sensors will provide total coverage of hazardous weather information at 18000 ft and above (to 12,500 in critical areas) in the high traffic density airspace.

QUANTITIES: 14 Wx radars to be purchased and installed by Atmospheric Environment Services - 1982-84. 22 RAMP Primary Radar Wx Channels by 1991. 6 DND ATC (TRACS) Weather Radar Channels. 13 TC WX radars 1991-2000.

RELATED PROJECTS/ACTIVITIES:

- Regional Aviation Weather Processor
- Canadian Aeronautical Digital Network
- Radar Moderization Project.

SCHEDULE



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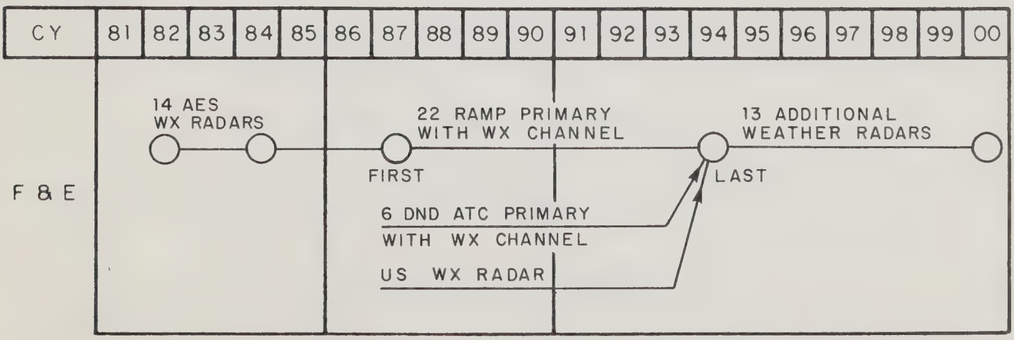


PROJECT: RADAR MODERNIZATION PROJECT (RAMP)

PURPOSE: To replace and modernize all ATC primary and secondary enroute and terminal radar systems. To provide modern SSR systems to replace data currently obtained from DND sites.

Replacement of existing radar systems is necessary because of decreasing data quality and availability, and increasing maintenance costs. New, solid state PSR's utilizing advanced signal processing techniques, and incorporating a weather channel along with Mode S compatible monopulse SSR systems will provide timely and accurate data to the ATC system. Through the utilization of remote monitoring and solid state electronics, maintenance workload and logistics costs will be reduced considerably.

APPROACH: Twenty two colocated PSR and SSR Systems, will replace existing radar systems.

Seventeen Independent SSR's, in conjunction with the colocated systems, will provide total SSR enroute coverage above 18000 feet in the high density traffic area.

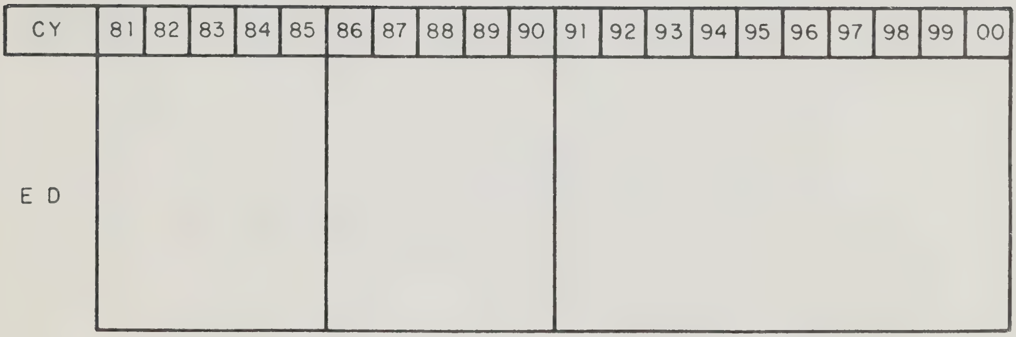
Data from all new radars will be digital only. Extensive use of alternate routing will distribute the surveillance data in a reliable, cost effective manner.

QUANTITIES: 22 colocated primary and secondary surveillance radar systems. 17 independent secondary surveillance radars.

RELATED PROJECTS/ACTIVITIES:

- Mode S Data Link
- Weather Radar System
- Remote Maintenance Monitoring System.

SCHEDULE



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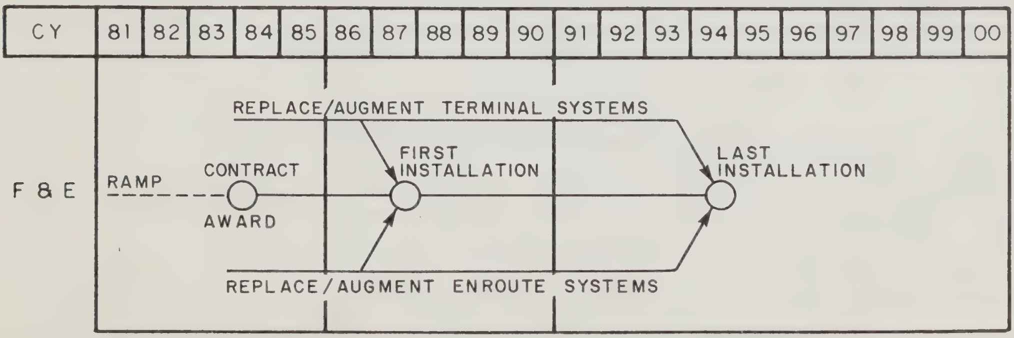


PROJECT: AIRPORT SURFACE DETECTION EQUIPMENT

PURPOSE: To provide selected towers with surveillance data of the position of aircraft and vehicles on the manoeuvring area of airports. To enhance the system by providing alphanumeric aircraft identification tages for ASDE displays.

At busy airports, the monitoring of aircraft and vehicle positions, particularly in reduced visibility conditions, is required to ensure safe, and efficient operations.

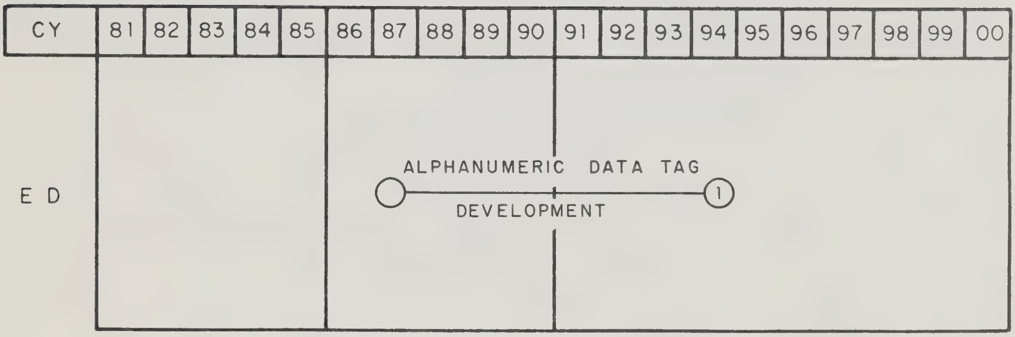
APPROACH: A contract will be issued to provide for equipment and and installation of 7 ASDE's at major airports. Deliveries of systems will begin in 1984, with the last of these being installed by 1988. The three systems presently installed will be replaced under this program. Additional systems may be required in the future as traffic demands warrant.

QUANTITIES: 7 ASDE's.

RELATED PROJECTS/ACTIVITIES:

- Mode S Data Link.

SCHEDULE



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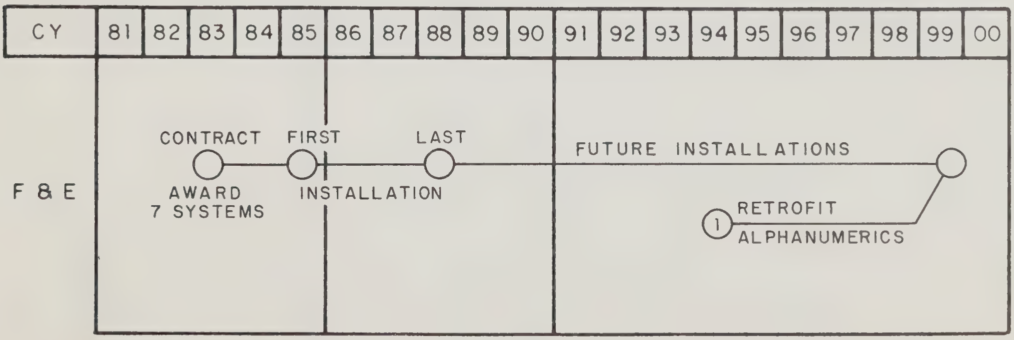


PROJECT: MODE S DATA LINK UPGRADE

PURPOSE: To provide a data link capability, using SSR Mode S, to permit automatic exchange of ATS messages, weather and automated traffic advisory information. This capability will be provided in the high density traffic area consistent with the coverage of SSR.

APPROACH: The monopulse SSR equipments will be modified to incorporate Mode S capability and thus provide a couputer to cockpit message for weather and air traffic messages. The system may also be utilized for automated ground based traffic advisory to provide aircraft separation assurance services in terminal areas. Mode S will provide improved quality surveillance data, by the elimination of interference, through the discrete addressing of aircraft. Improved airborne and airport operation through digital data link services will result in increases in air traffic controller productivity.

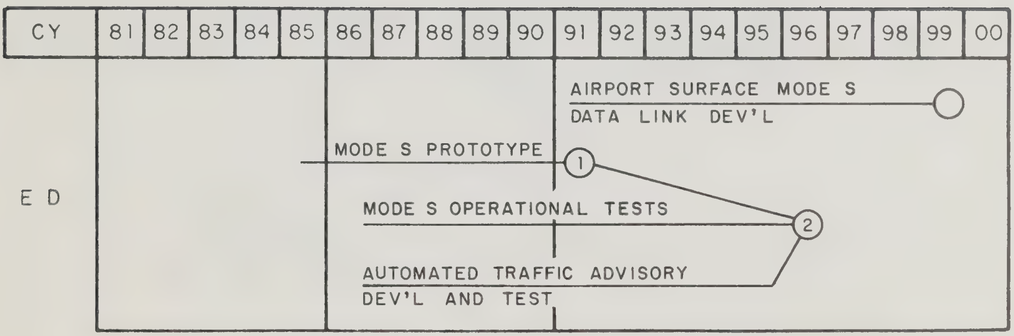
A contract will be issued in 1990 for retrofit upgrades for all 39 monopulse SSR systems.

QUANTITIES: 39 monopulse-to-Mode S upgrades will be performed, between 1994 and 2000.

RELATED PROJECTS/ACTIVITIES:

- Radar Modernization Project
- Advanced Integrated ATC System
- Airport Surface Detection Equipment.

SCHEDULE



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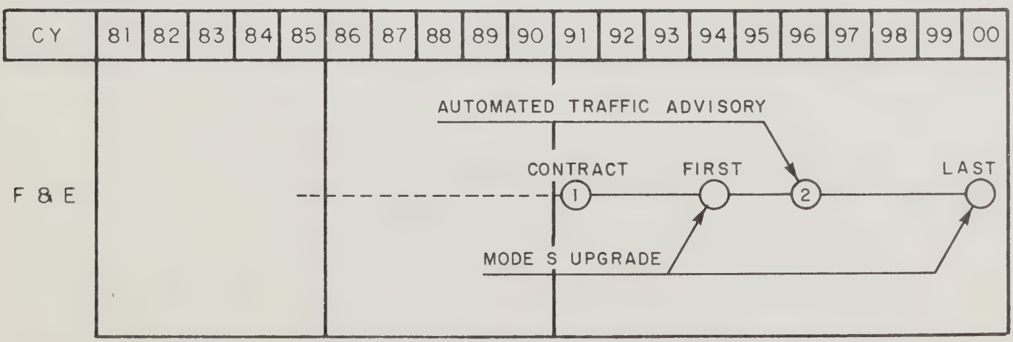


PROJECT: CONSOLIDATION OF COMMUNICATION NAVIGATION AND SURVEILLANCE FACILITIES

PURPOSE: To physically consolidate and colocate, where feasible, communication, navigation and surveillance facilities.

There are at present approximatedly 350 facility sites which can be considered for consolidation. This will result in cost savings through land use reductions, reduced maintenance travel, reduced site maintenance (heating, air conditioning, road maintenance) and reduction in inter-facility communication.

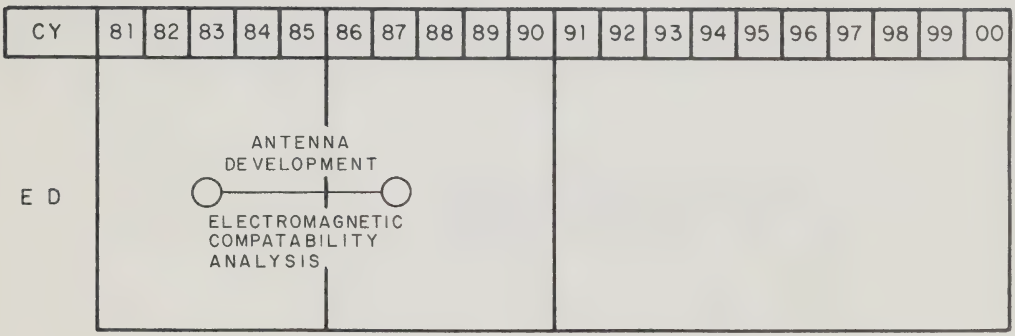
APPROACH: Consolidation will be initiated at sites where multiple communication facilities exist and when solid-state equipment and remote maintenance monitoring is installed. Remote communication facilities not already assocaited with NDB's and or VOR's will be consolidated. Where possible consolidation of VOR and VHF-DF will be considered. New and stand-alone peripheral communication facilities will be consolidated with their associated surveillance site.

QUANTITIES: Number of facilities involved - approximately 350.

RELATED PROJECTS/ACTIVITIES:

- Air-Ground VHF communication
- Remote Maintenance Monitoring System
- VOR-DME-TACAN
- Radar Modernization Project
- Non Directional Beacons.

SCHEDULE



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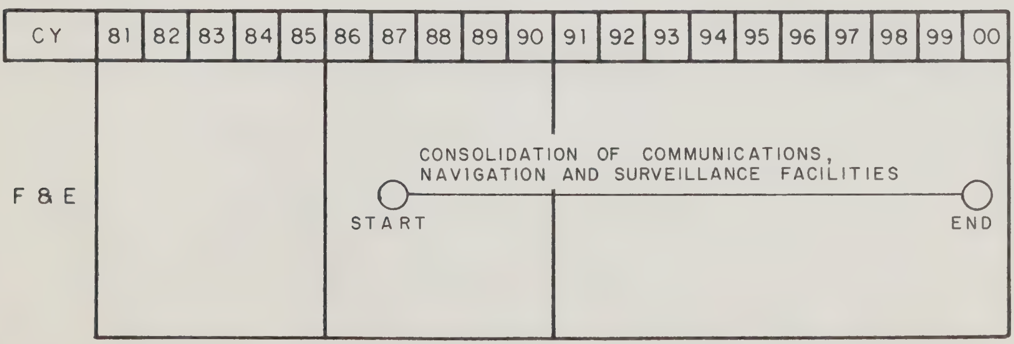


PROJECT: SATELLITE DERIVED ENROUTE NAVIGATION, COMMUNICATIONS AND SURVEILLANCE

PURPOSE: To carried out engineering development work on satellite system(s) in cooperation with other countries in order to establish future system designs. To determine the feasibility of providing navigation, communications and surveillance from a common satellite system.

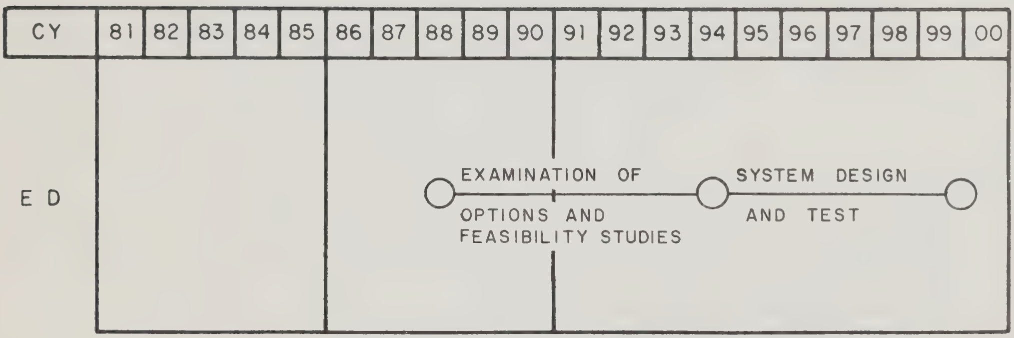
APPROACH: Studies will be carried out in conjunction with other countries to examine existing satellite navigation and communications satellite systems including NAVSTAR, INMARSAT etc. The potential for combining requirements for navigation, communications and surveillance in one domestic civil aeronautical satellite for use in the North American environment will be explored with the USA.

QUANTITIES: As required.

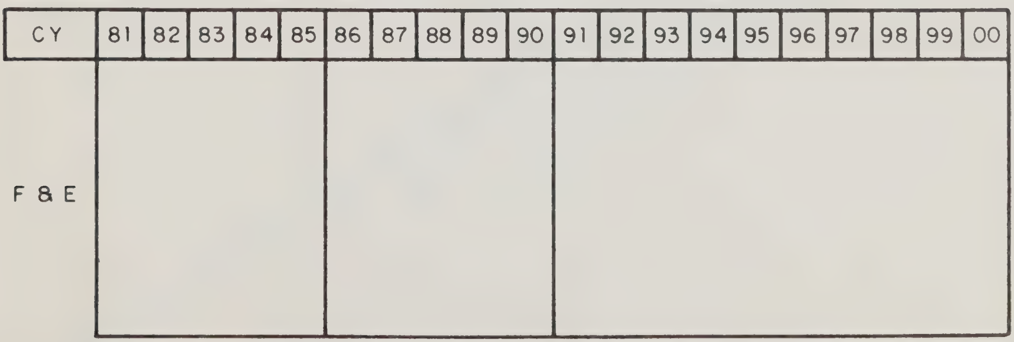
RELATED PROJECTS/ACTIVITES:

- None.

SCHEDULE



SCHEDULE



CHAPTER 7

INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEM

INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEM

Interfacility systems provide voice and data communications between major facilites such as Air Traffic Area Control Centres (ACC), Terminal Control Units (TCU), Flight Service Stations (FSS), and Towers; smaller remote facilities such as navigation aid, communication, and surveillance sites; and internationally with the USA, Europe, Iceland and Greenland. In general, dedicated circuits used exclusively by Transport Canada carry voice and/or data between facilities. Point-to-point voice grade circuits provide links between ATS facilities and provide links for monitoring and control of navigation, communication, and surveillance sites. Networks consist of voice grade circuits or low speed data circuits. The circuits provide links to over 18,000 systems installed at more than 2000 sites at a leased cost over $19,000,000 annually.

Intrafacility systems provide voice and data communications within ANS facilities. These range from single circuit simple point-to-point systems to complex local area networks depending on the nature and size of the facility.

Data communications involves the combination of data source, medium, and receiver in various kinds of communications networks. The medium chosen is determined by exploring factors such as cost, speed, reliability, the availability of the medium, and the urgency of the requirements.

In the ANS system communications lines are used which could consist of one or more channels - a channel is a means of one-way communication. The direction of information flow is determined by the characteristics of the devices at each end of the channel. By using suitable terminal equipment the direction of flow along the channel can be alternated and thereby produce a half-duplex (HDX) system. If more channels are added then both way or full duplex (FDX) transmission can occur.

To send information from one point to another suitable coders and decoders which translate data into a form that the line can handle and that the terminal devices can interpret are used. All data communications use a binary system of codes which are made up of a number of binary digits (bits). Transmission medium capacity is usually expressed in the number of bits per second it can handle. The number of bits which make up the code limit the number of letters/characters/ symbols/etc. that can be represented. Two commonly used codes are Baudot (5 bits) and ASCII (8 bits). Telex is a major user of Baudot but a large number of data systems rely on ASCII due to its flexibility and inherent means of error checking. The code contains 32 control characters divided into separate generic classes:

- Transmission controls used to control the flow of data along the lines.

- Format effectors used to control the physical layout of information on a printed page or on the screen of a VDU.

- Device controls used primarily for controlling auxiliary devices at the terminals.

- Information separators which logically delimit elements of data.

The control characters do not usually appear on the text but are carried as overhead on the communications system to ensure that what is received is what was transmitted.

There are two basic approaches to transmitting data - parallel transmission and serial transmission. In parallel all bits of an encoded character are transmitted simultaneously along separate channels. In serial the bits of the encoded character are transmitted one after the other along one channel. Serial transmission requires the receiver to first achieve bit synchronization and then achieve character (or intelligence block) synchronization. Transmissions can be synchronous (i.e. continuous) or asynchronous whereby the receiver clock is started at the beginning of each character.

Many control and other communications characteristics are functions of the hardware/software of the transmission system and require no operator intervention. Synchronous transmissions are more efficient due to the lower number of overhead bits required. The maximum efficiency in an asynchronous system is 80%.

A good technique for increasing the efficient utilization of telecommunication links is to use multiplexers or concentrators. A multiplexer is a transparent device that divides the capacity of a communications link between a number of terminals. The two basic approaches are time division multiplexing or frequency division multiplexing. When using multiplexers each terminal thinks it has a point-to-point relationship with other terminals.

A concentrator (or communications processor) is a computer based device that usually has some form of mass data storage. Because it alters the form of a data stream, it can be interfaced to a varied network ranging from low speed asynchronous lines through medium speed synchronous and asynchronous lines to high speed applications. The concentrator, by handling part of the telecommunications network functions, can take some load from a central communications processor or even a host computer. Concentrators on complex networks are sometimes referred to as nodes. If a concentrator is equipped with sufficient storage, it can act as a store and forward device in that it will assemble complete messages or blocks of messages, store them in memory, and then forward them to their proper destination. A concentrator can be used to perform code, speed, and format conversions, thereby accommodating a spectrum of different terminals from a network.

The concentrator and the multiplexer represent two different degrees of telecommunications capability. In between are devices with varying functions that are usually referred to as "intelligent multiplexers".

A data communications network can be a simple collection of terminals, lines, and computers or it can be a complex system with hundreds of terminals and many computers connected across thousands of kilometers.

There are four basic network configurations that can be used:

- The STAR network whereby each terminal is connected to a central site by a point-to-point single terminal line, multi-drop lines, or smaller STAR networks. To lower line costs a STAR network using multi-drop (or multi-point) lines can be used whereby two or more terminals are connected to one line. Because terminals cannot transmit simultaneously, line control procedures are necessary such as polling in which the central site invites the terminals, in an orderly fashion, to transmit data. Each terminal has a receiver which recognizes only it's address and responds to that address, ignoring all others. The STAR network is entirely dependent on the integrity of the central site. If two terminals wish to communicate they must do so through the central site.

- The RING network which consists of a number of computers (or concentrators) connected together in a loop or ring. In this way a single path can be established along separate routes and if any one path fails another link will be available.

- The MESH network is an expansion of the RING network which interconnects many cities and many terminals. The deciding factor to establish a MESH network include line costs, geographical distribution of the data interchange requirements, and the volume of data to be distributed throughout the network.

- The HIERARCHIAL network which uses various levels of computers and concentrators connected in a similar way as a government organizational chart.

In many applications, terminals may need to transmit data for relatively short times in a day so use can be made of various switched networks. These networks enable the establishment, on demand, of a point-to-point connection between two terminals. This connection is maintained as long as needed. The telephone network is a good example of a switch network.

In designing the network, tradeoffs are made between reliability, efficiency, and costs with the result that any one system may contain different types of networks.

Although most interfacility systems are leased, some are owned by the Administration. Systems owned by the Administration are either radio links (microwave for radar data or UHF/VHF for remote monitoring, control, and operation) or cable distribution systems on airports (for example for ILS remote monitoring, control and operation). Within each operational unit there are several intrafacility systems consisting of voice or data local area networks for each sub-system. These local area networks (as used by systems such as the ICCS, JETS, OIDS, etc.) are not interlinked at the present time.

The leased services are provided by the major Common Carriers for national and international sytems and the local Common Carriers for local regional circuits. Canada fulfills its commitment to the world-wide Aeronautical Fixed Telecommunication Network (AFTN) with a low speed teletype domestic network called the Automated Data Interchange System (ADIS). ADIS interfaces internationally with a circuit to the USA and several circuits to Europe, Iceland, and Greenland. ADIS is also interconnected to the centralized automated NOTAM system. The AES Meteoroglical teletype network, for the most part, parallels the ADIS network but is not interconnectable to ADIS. Present day voice and data communication networks have been implemented for specific service functions and are not interconnectable. Short distance, point-to-point circuits (such as the cross-border circuits to the USA) have proliferated over the years in an attempt to solve local operational problems.

Most ADIS circuits are low-speed 200 bits per second (bps) or less. Medium speed data circuits (1200-9600 bps) link the FAA and Canadian AFTN switches at Kansas City and Montreal. Digitized radar data for input to automated systems (such as JETS) use circuits at bit rates of 2400 bps. One optical fibre circuit connects the two air terminal buildings at Toronto International Airport, for the passing of security and airport operational information.

Interfacility and Intrafacility Systems evolved over time as requirements dictated and technology allowed. Leased circuit costs were low, thereby resulting in the proliferation of single-user circuits along parallel paths. Leased services were generally provided by the Common Carriers. Continuing to provide inter- and intrafacility systems as in the past will increase costs to the ANS system at an unacceptable rate because basic circuit costs are escalating, competition is not being fully utilized, and the new technology is not being exploited.

THE NEW APPROACH

A total systems approach will be taken in the future development and implementation of the Interfacility and Intrafacility communications system.

In order to constrain costs and to provide operating flexibility, communications networks will be combined to the greatest extent possible through the use of distributed switching intelligence and other modern techniques. Transition to the future systems will be evolutionary and the first step will combine the data networks into an integrated system called the Canadian Aeronautical Digital Network (CADIN). The digitization of voice will allow voice interfacility systems to be integrated into the CADIN. CADIN will include distributed communications computers (intelligent nodes) with high speed links interconnecting the major ATS facilities and medium speed links interconnecting the FSS hubs, satellite FSS, and the remote navigation aid, communication, and surveillance sites.

Intrafacility communications requirements will utilize the inherent redundancy of local area networks employing distributed processing techniques. This approach will result in a more highly fault-tolerant system than previously possible with single or dual processor configurations. Because of the intrinsic modularity of distributed sytems, expansion will be facilitated permitting upgrading or additions.

HOW THE SYSTEM WILL EVOLVE

NEAR TERM (to 1985)

In order to establish a foundation for network evolution to CADIN, activities are underway to upgrade system performance with emphasis on constraining costs.

The ancient teleprinters on the ADIS have recently been replaced with Visual Display Units. The old terminal address selectors have been replaced by computer type integrated circuits (EPROM).

A study into facsimile usage within the Administration has recently been completed. The study found the various machines to be incompatible and operations costs excessive. During this period the old analogue facsimiles will be replaced by modern digital machines which can be easily networked at a reasonable cost.

Most communications links are short-haul point-to-point and join ACC's, TCU's and FSS's to remote sites or to each other. They are normally leased on a piecemeal basis in accordance with published tarrifs. Some savings have been realized through the competitive bulk leasing of voice grade lines. The number of lines required has been decreased through the use of time division multiplex equipment where both control and voice are needed.

The pushbutton telephone equipment installed up to 25 years ago and now almost impossible to maintain, will be replaced at all towers, TCU's, and FSS's. Plans are being formulated to integrate these functions into the next generation of communication control equipment.

The ADIS message switching computer will be upgraded in 1983. This will permit enhanced message formatting, flexibility of message handling, and the inclusion of new message traffic-types such as weather information and flight plan data. The network will be reconfigured to include higher speed circuits to the major ATS centres. Initially, the switch will be connected to Kansas City but it will eventually operate to Salt Lake City when the FAA National Data Interchange Network becomes operational. The weather information provided to and from AES will be carried on ADIS thereby eliminating the duplication of circuits that now exist. The upgrading and reconfiguration of the network will be completed by the end of the period.

The present centralized semi-automated NOTAM system which utilizes the ADIS/AFTN network, enables the online collection, distribution and bulletin preparation of NOTAM information and provides automatic request/retreival capability to authorized users. The system will be upgraded to allow an international data base update. The international NOTAM office terminals are now being replaced by new terminals.

INTERMEDIATE TERM (TO 1990)

There will be significant changes as the ADIS evolves into a general purpose, data transmission system with alternate routing capabilities to bypass failed or saturated areas. Local communications processors will be established, to complement the central communications switch, in each flight information region with links to remote sites. These processors will allow direct communications between ATS facilities within an FIR without having to pass all data through the central communications switch. ADIS will be designed to utilize whatever transmission medium proves to be the most cost effective. This network will become the backbone to the entire interfacility communications system.

Multiplexed circuits will be used to connect multiple remote points to the network's backbone. Circuits into high capacity lines that transmit and receive numerous messages simultaneously (multiplexing), allows facilities requiring access to the network to do so in a cost-effective manner. It eliminates a large percentage of individual lines.

Remote maintenance monitoring systems will begin to be implemented with data transfer via the upgraded ADIS.

Communications control equipment capable of carrying both voice and data will be installed at TWR's, TCU's and FSS's in the late 1980's. These systems will consolidate the single-user intrafacility circuits at these places into multipurpose local networks. Separate data and voice lines will still be needed for interfacility purposes during this transition period but the basis for a complete communications network will be established. Development work will be underway on the digitization of voice which, when evenly implemented, will allow widespread integration of voice and data communications. The total network will encompass the backbone, the local short haul point-to-point links, and the local area networks thereby allowing facility consolidation and other activities requiring cost-effective telecommunications to proceed.

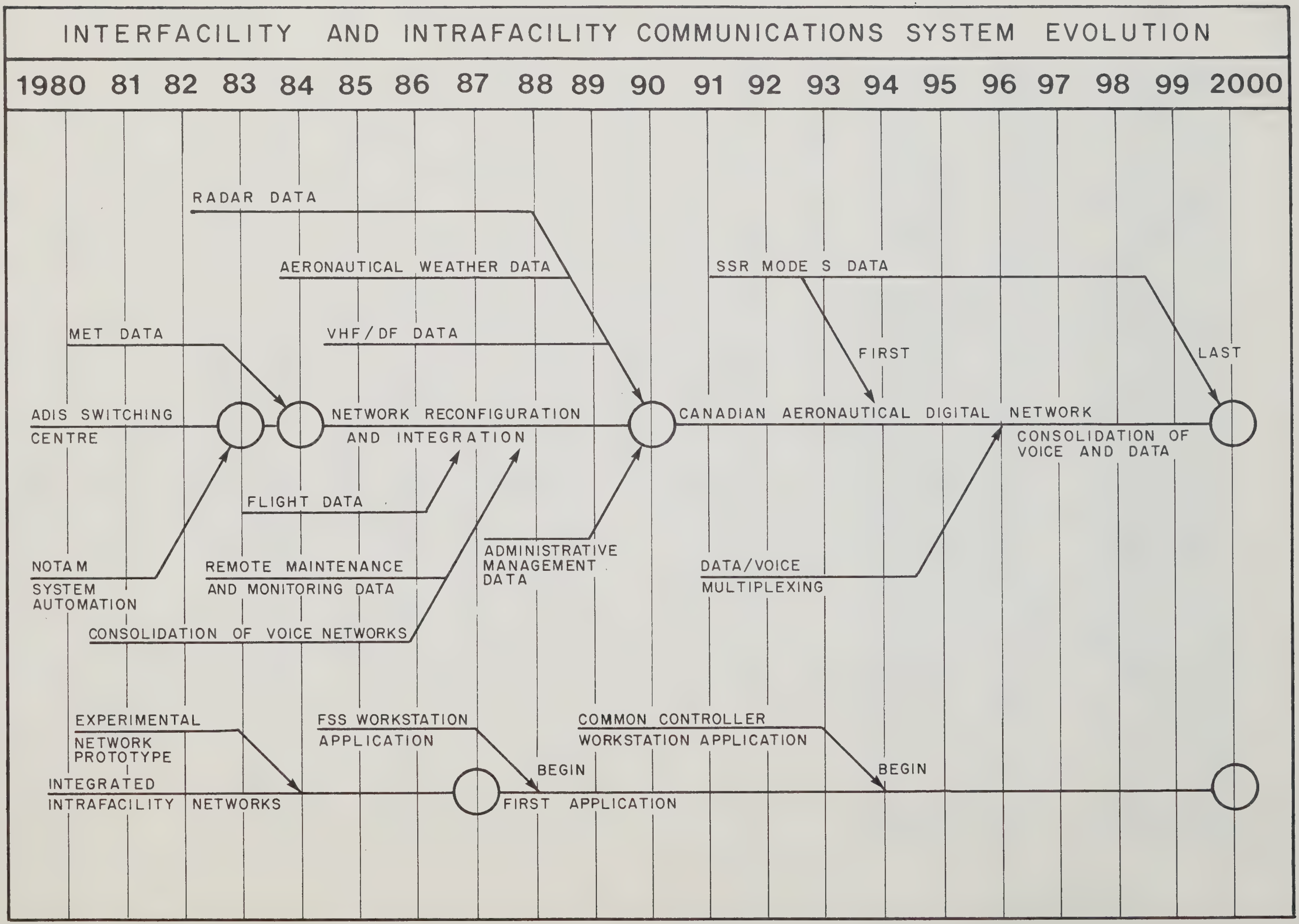
During this period the transmission media will be a mix of terrestrial and satellite circuits. Due to the geographic characteristics of Canada and the predominent east-west concentration of high capacity terrestrial links, multiplexing the north-south telecommunications circuits into satellite trunks will become more common.

LONG TERM (TO 2000)

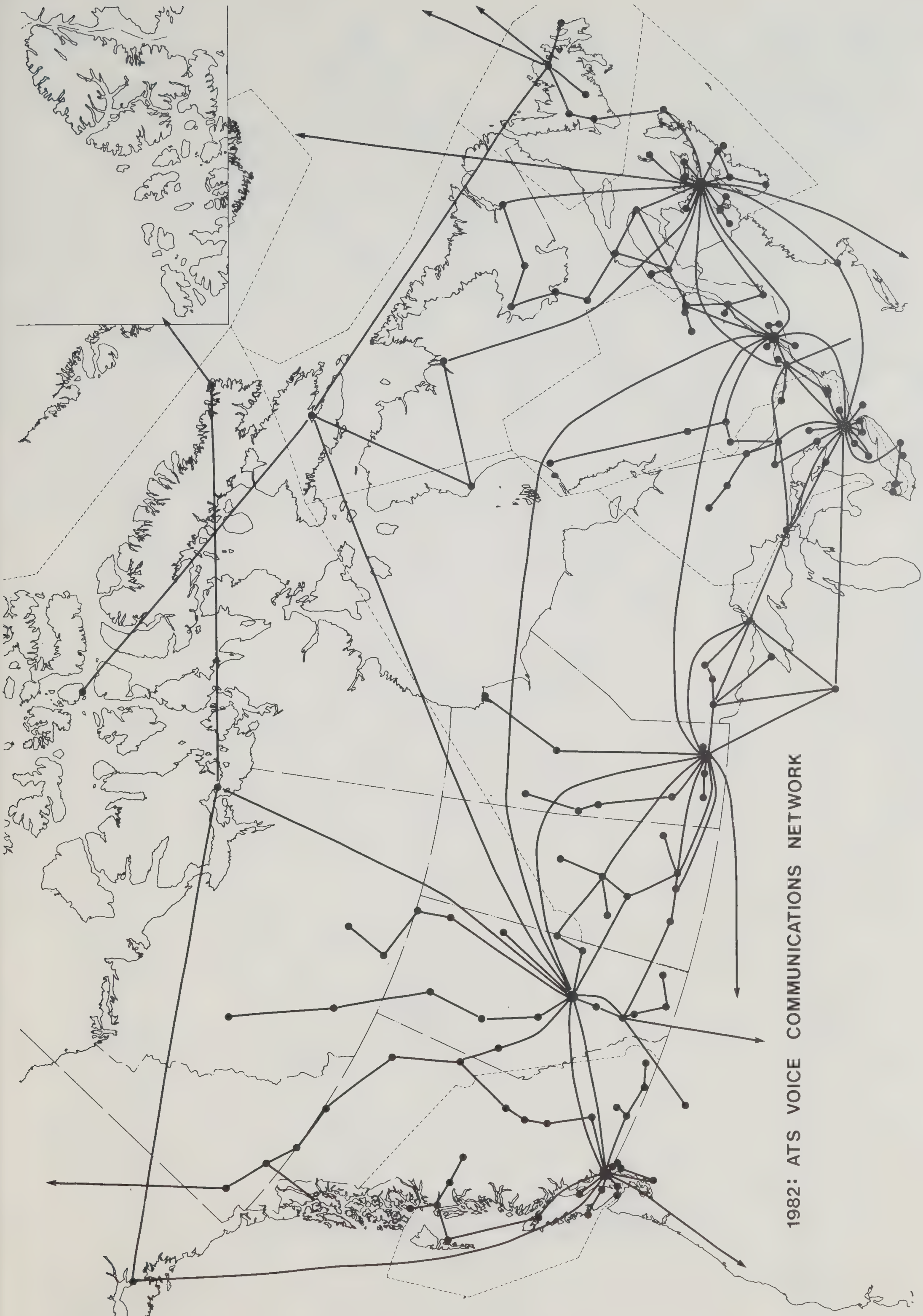
In the long term as more facilities are consolidated, as SSR Mode S and data-linked dependent surveillance are introduced and as more automated stations are installed, increasing interfacility requirements must be accommodated. Digitized voice and data will be integrated into a distributed Canadian Aeronautical Digital Network (CADIN). The redundancy built into the network will ensure high reliability and availability.

The ICCS will be replaced in the mid 1990's by a fully integrated intrafacility local area network at the Area Control Centres. This development will allow for the implementation of the common work station concept.

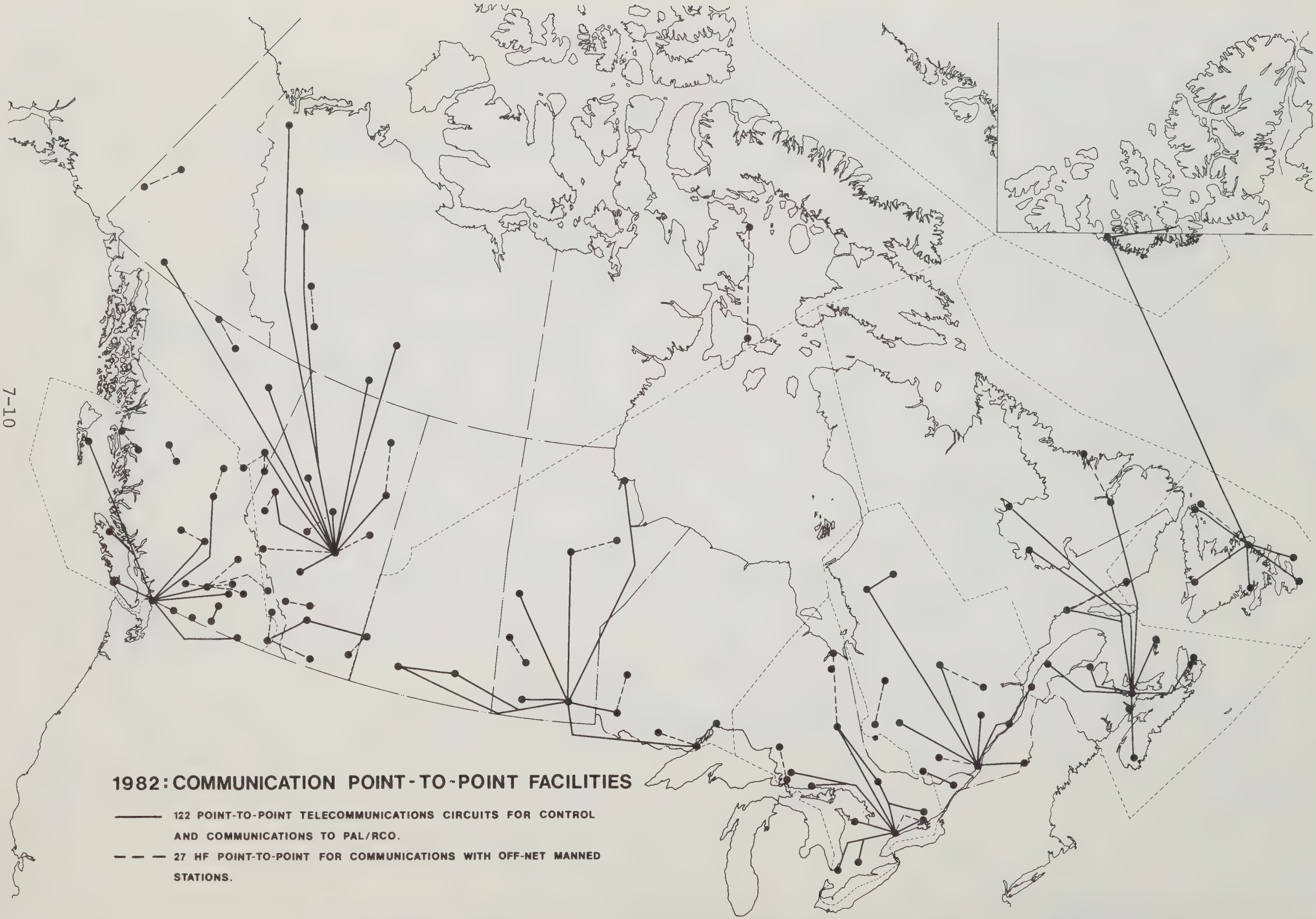
Transmission media and technologies are likely to change within this period. Continuing analysis of need and detailed investigations will occur to take into account the increased efficiency and reduction in costs that the use of such media may bring.

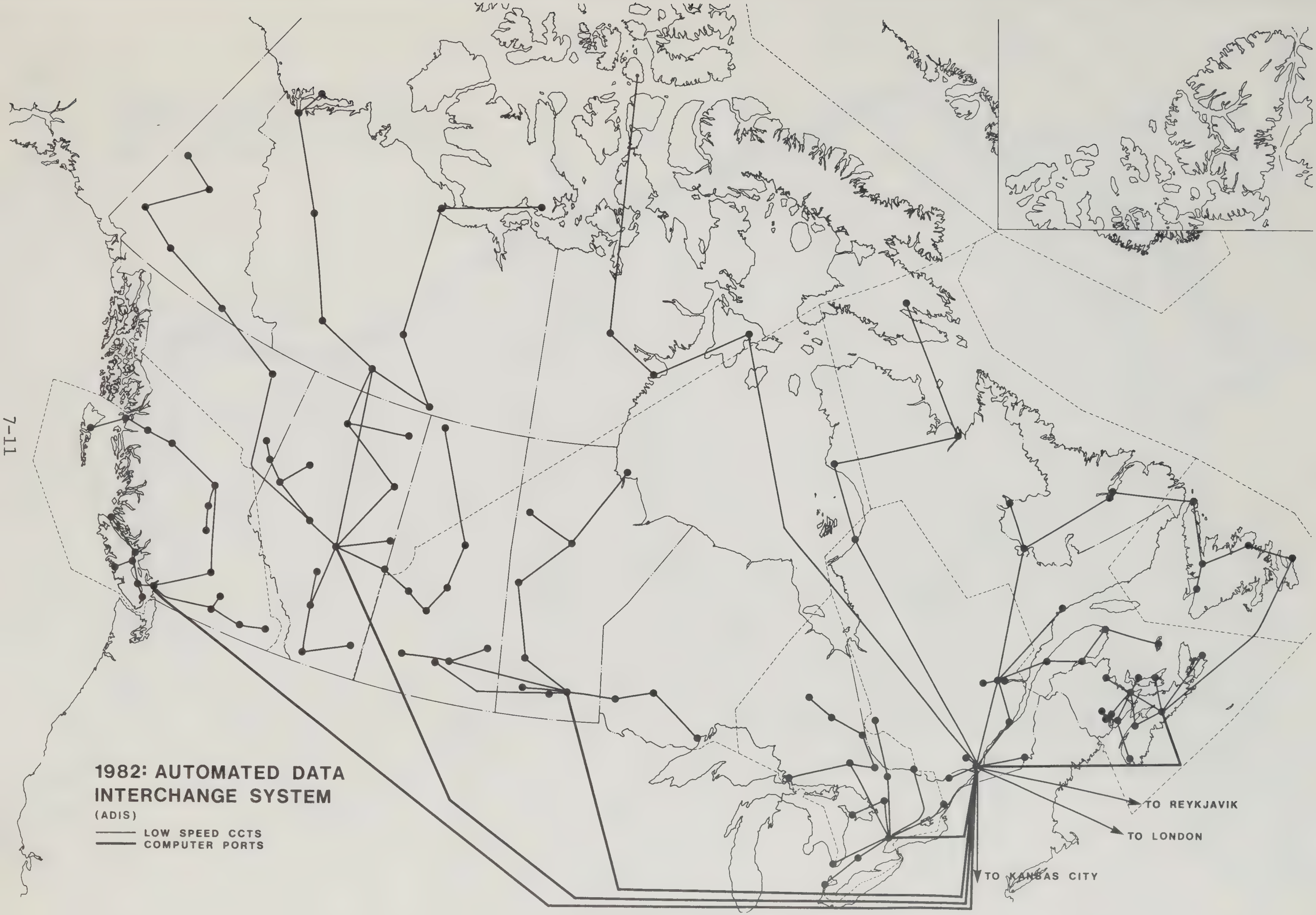


INTERFACILITY AND INTRAFACILITY COMMUNICATIONS SYSTEM EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
RADAR DATA
AERONAUTICAL WEATHER DATA
SSR MODE S DATA
MET DATA
VHF/DF DATA
FIRST
LAST
ADIS SWITCHING CENTRE
NETWORK RECONFIGURATION AND INTEGRATION
CANADIAN AERONAUTICAL DIGITAL NETWORK
CONSOLIDATION OF VOICE AND DATA
FLIGHT DATA
NOTAM SYSTEM AUTOMATION
REMOTE MAINTENANCE AND MONITORING DATA
ADMINISTRATIVE MANAGEMENT DATA
DATA/VOICE MULTIPLEXING
CONSOLIDATION OF VOICE NETWORKS
EXPERIMENTAL NETWORK PROTOTYPE
FSS WORKSTATION APPLICATION
COMMON CONTROLLER WORKSTATION APPLICATION
BEGIN
BEGIN
INTEGRATED INTRAFACILITY NETWORKS
FIRST APPLICATION



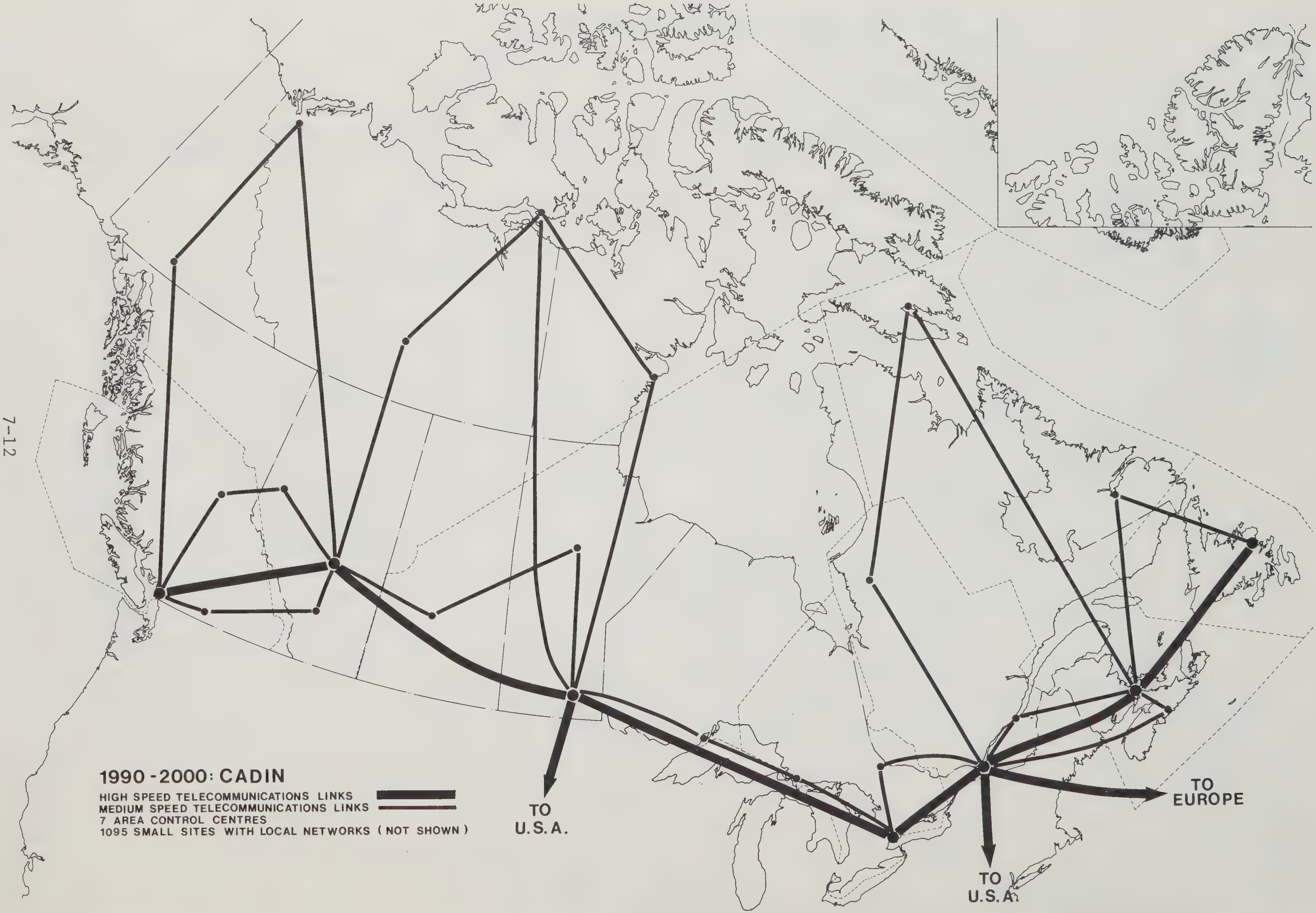
1982: ATS VOICE COMMUNICATIONS NETWORK


1982: COMMUNICATION POINT-TO-POINT FACILITIES
122 POINT-TO-POINT TELECOMMUNICATIONS CIRCUITS FOR CONTROL AND COMMUNICATIONS TO PAL/RCO.
27 HF POINT-TO-POINT FOR COMMUNICATIONS WITH OFF-NET MANNED STATIONS.



1982: AUTOMATED DATA INTERCHANGE SYSTEM
(ADIS)

LOW SPEED CCTS
COMPUTER PORTS



1990 - 2000: CADIN
HIGH SPEED TELECOMMUNICATIONS LINKS
MEDIUM SPEED TELECOMMUNICATIONS LINKS
7 AREA CONTROL CENTRES
1095 SMALL SITES WITH LOCAL NETWORKS (NOT SHOWN)
TO U.S.A.
TO U.S.A.
TO EUROPE

PROGRAM	IMPLEMENTATION	
	1st	Last
INTERFACILITY COMMUNICATIONS		
1. ADIS Switching Centre	1983	
2. NOTAM System Automation	1983	
3. Network Reconfiguration and Integration	1984	1990
4. Canadian Aeronautical Digital Network (CADIN)	1990	
INTRAFACILITY COMMUNICATIONS		
1. Integrated Intrafacility Networks		
(a) Small Systems	1986	1996
(b) Large Systems	1991	1997

PROJECT: ADIS SWITCHING CENTRE

PURPOSE: To improve the message switching capability on the domestic ADIS network and on the International Gateway to the world-wide AFTN. Not only is the present switch, in Montreal, nearing the end of its operational life but it cannot accommodate the near term procedural changes required by ICAO. The present switch is also not capable of accepting the higher data rate circuits needed to cope with the increasing message traffic and new services to be carried on the data network.

APPROACH: The new switch will be leased for a period of at least 5 years commencing in 1983.

QUANTITIES: One dual switch in Montreal.

RELATED PROJECTS/ACTIVITIES:

This is a master project which will impact on all other projects required to have data transferred in a message format.

For example:
1. Flight Data Processing System
2. Central Aviation Weather Processor
3. Automatic Weather Observation and Reporting System
4. Communications Control System
5. Consolidation of Manned FSS
6. GAATS
7. Aeronautical Information Processing Ssytem
8. Network Reconfiguration and Integration.

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
F & E	CONTRACT		SWITCH OPERATIONAL																	

PROJECT: NOTAM SYSTEM AUTOMATION

PURPOSE: To upgrade the present automated Notices to Airmen (NOTAM) system which caters only to domestic NOTAM's, into a fully integrated request/reply database capable of being interrogated by all users of domestic and international NOTAM's.

NOTAMS are essential to the safety of flight because they provide information on abnormal conditions or outages to ANS and airport services that exist. They are also time critical. At present, users that require NOTAM's outside of their normal area of coverage request this information from the central NOTAM Office database. The reply however, contains only information on Canadian facilities. Required information on international (foreign) facilities must be manually compiled and transmitted separately by the NOTAM office staff.

The aim of the project is to enhance services to aviation and improve person-year utilization by providing automatically all of the desired information.

APPROACH: The old terminals will be replaced immediatly. Software improvements to permit full automated operation will be implemented. In the automated systems, operator intervention will only be required for verification of NOTAM accuracy or if an unusual situation develops. Additional storage capacity will be obtained to accommodate the international data base. It is intended to lease the system until at least 1988.

QUANTITIES: One dual system colocated with the ADIS switch in Montreal.

RELATED PROJECTS ACTIVITIES:

- ADIS Switching Computer
- Network Reconfiguration, and Integration
- Controller Work Station
- FSS Work Station
- Direct User Access Terminal
- Regional Aviation Weather Processor
- Aeronautical Information Processing System
- Remote Maintenance Monitoring System.

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
F & E	IMPLEMENTATION OPERATIONAL																			

PROJECT: NETWORK RECONFIGURATION AND INTEGRATION

PURPOSE: To reconfigure the existing data network, economically provide improved services, provide for future expansion, improve reliability and survivability, and reduce leased line requirements. This project will result in an integrated data network.

The present ADIS network consists of 64 low speed (200 bit per sec or less) single drop or multi-point ASCII teletype circuits fanning out from a central switch located in Montreal. One medium speed line (1200 bit/sec) circuit links Montreal to the Kansas City AFTN switch. An almost parallel low speed network operated by AES is used for the collection and dissemination of weather information from/to the AES computer in Toronto.

If we continue to provide the data communications as we have in the past then the costs to the ANS system will increase at an unacceptable rate because basic circuit costs are escalating, competition is not being fully utilized, and the new technology is not being exploited.

APPROACH: Initially the existing network will be optimized to take advantage of the capability of the new ADIS switch to implement higher capacity links on some overloaded circuits.

The AES network to ATS facilities will be eliminated and all required aviation weather information will be carried on ADIS.

The future system design will be based on the projected data requirements for the enroute and terminal, air/ground, FSS, and aviation weather system. Message switching techniques will be used until at least 1988.

This project is a prerequisite to the Canadian Aeronautical Digital Network (CADIN.)

QUANTITIES: Enhancement and expansion of the present ADIS Network.

RELATED PROJECTS/ACTIVITIES:

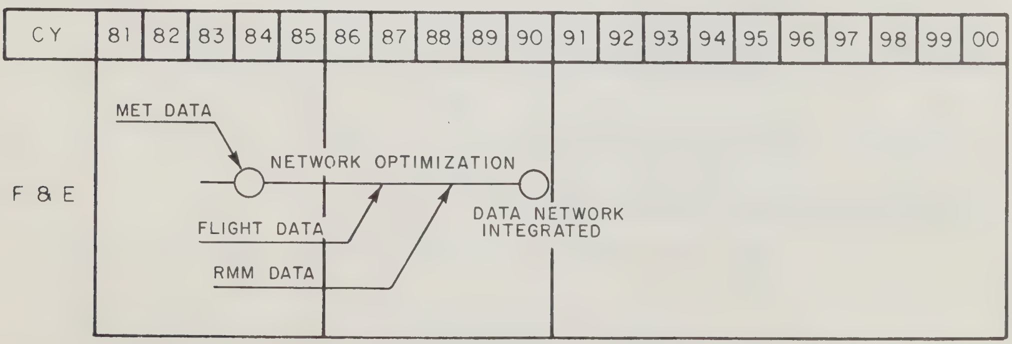
This is one master project which will impact on all other projects required to have data transferred in a message format.

For example:
1. Flight Data Processing System
2. Central Aviation Weather Processor
3. Automatic Weather Observation and Processing System
4. Direct User Access Terminal
5. Communications Control System
6. Consolidation of Manned FSS
7. GAATS
8. Aeronautical Information Processing System
9. ADIS Switching Computer
10. Canadian Aeronautical Digital Network.

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE



PROJECT: CANADIAN AERONAUTICAL DIGITAL NETWORK

PURPOSE: To provide an efficient, cost-effective, integrated, common user network to replace the ADIS.

In addition to the data carried by ADIS, the increased requirements stipulated in the Canadian Airspace Systems plan, the ICAO planning for the Common ICAO Data Interchange Network (the future evolution of the AFTN), the digitization of the voice networks, and future unforseen requirements necessitate a complete upgrade of the interfacility system to the CADIN.

As CADIN evolves into an all encompassing digital communications network, it will provide the required flexiblity and interoperability demanded by the Canadian airspace system. The alternative of dedicated independent lines will not provide the above capability and would be prohibitive in cost.

APPROACH: A highly connected, code and byte independent, switched network with virtual circuit and alternate routing capability will be implemented to initially accommodate the data communications needs. As work progresses on the digitization of voice systems they will be integrated into CADIN. A centralized network control and monitoring facility will be established. Standardization of access interface and an appropriate protocol will be maintained to ensure future flexibility and evolution of the system. Message switching will continue to be provided for quick response, interactive data transfer, and efficient file (data base) transfer capability. Nodes and concentrators will be added as required.

The following activities will occur:

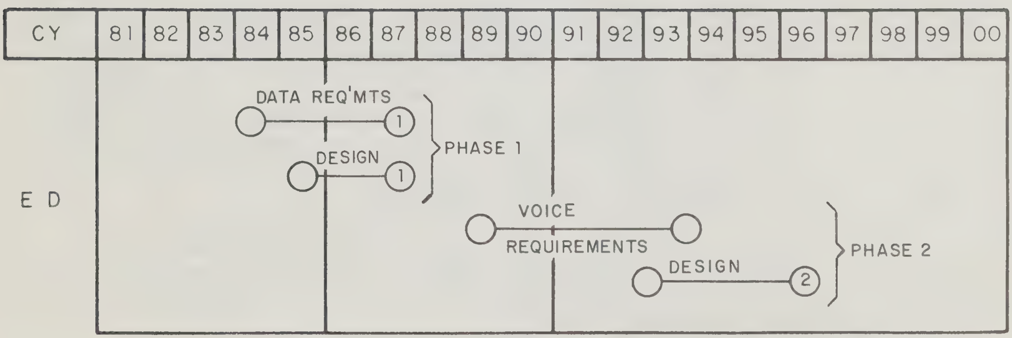
- Engineering Development for networking, leading to design and specification.
- Implementation of nodes and added trunking.
- Implementation of additional capacity, connectivity and interfaces.
- Continued Engineering Development during the evaluation of the system.

QUANTITIES: Communications processors will be added as required. There will be at least one per FIR.

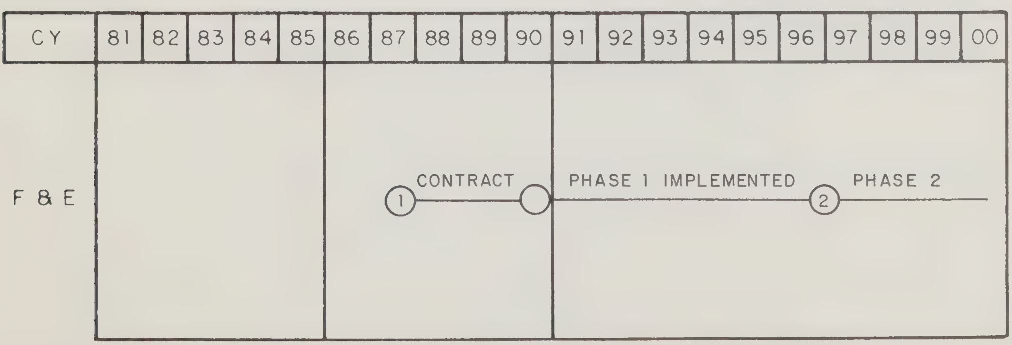
RELATED PROJECTS/ACTIVITIES:

- CADIN will provide the communications links between ANS facilities.
- The possibility of switching off peak hour administrative communications via CADIN will be investigated.

SCHEDULE



SCHEDULE



PROJECT: INTEGRATED INTRAFACILITY NETWORKS

PURPOSE: To provide ATS facilities with cost effective, flexible, fault-tolerant intrafacility communications (voice and data) systems based on local area network concepts.

Because ATS operational systems play a critical role in air safety, these intrafacility systems must be highly reliable both from the point of view of low number of equipment failures and high data integrity. The high cost of intrafacility systems also dictates that they be readily expandible thereby avoiding early obsolescence due to loading beyond the initial network capacity.

The inherent redundancy of local area networks employing distributed processing techniques should result in a more highly fault-tolerant system than previously possible with single or dual processor configurations. Because of the intrinsic modularity of distributed systems, expansion will be facilitated, permitting upgrading or additions.

APPROACH: Engineering development being conducted on distributed systems identified approaches for the implementation of reliable and flexible systems, based on local area networks.

As part of this investigation, an experimental local area network integrating both voice and data will be established to assess commercially available software with regards to its applicability to ATS systems and to identify future software development needs. The concepts defined in the investigation phase will be proven through simulations on a prototype system. These engineering development activities are expected to continue until 1987.

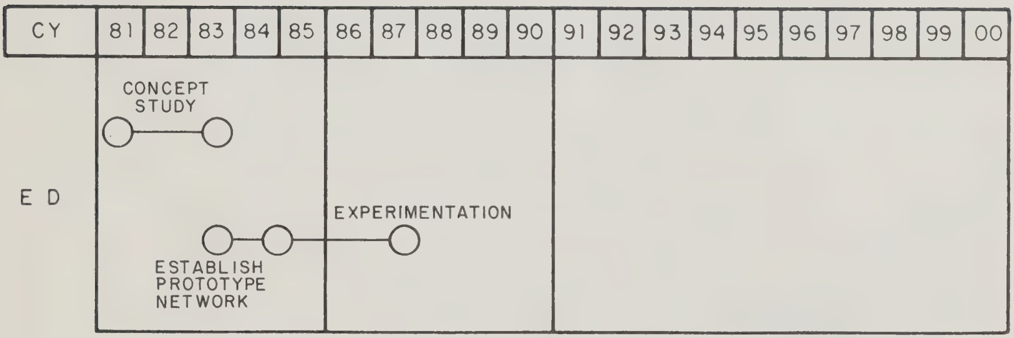
Partial integration of these intrafacility networks into operational systems will begin in 1987. Full implementation in an evolutionary manner will continue through the turn of the century.

QUANTITIES: At least one per ATS facility.

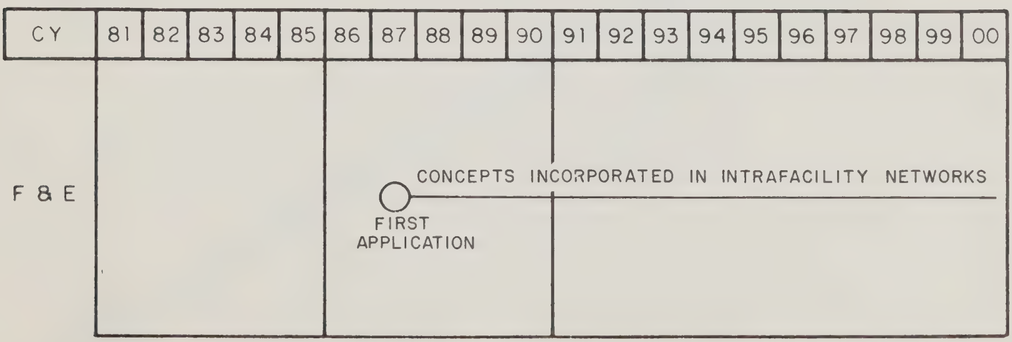
RELATED PROJECTS/ACTIVITIES:

- This project will have an impact on all ATS computer based systems.

SCHEDULE



SCHEDULE



CHAPTER 8

MAINTENANCE AND SUPPORT SYSTEMS

MAINTENANCE AND SUPPORT SYSTEMS

Maintenance and support systems include those auxiliary systems which are necessary for ensuring the continuing evolution, operation and performance of the Canadian Airspace System. These auxiliary functions support the system as a whole, as opposed to supporting a specific individual system. This chapter focuses particularly on the provision of flight inspection, maintenance, training and technical support.

FLIGHT INSPECTION

Flight inspection activities are an integral part of the maintenance function for navigation facilities.

Flight inspection encompasses:

- Confirmation that navigational aids and radars are acceptable for operational use (about 4500 flying hours yearly).
- Calibration of new navigational aids prior to commissioning.
- Assessment of new sites.
- Calibration of a facility performance after major maintenance or refurbishing.

Flight inspections are conducted by a fleet of nine aircraft, involving a total of about 5000 flying hours annually. Six aircraft are regionally based. Two aircraft, based in Ottawa, provide back-up and carry out flight inspections north of 60 degrees North Latitude. A third Ottawa based aircraft is provided for development of flight inspection systems and procedures.

MAINTENANCE

The maintenance function is organized into six Regions. Each Regional office provides technical administration and field maintenance management. In the field, maintenance is divided into areas, each area being under the direction of a Telecommunications Area Manager (TAM). Within an area, equipment can be located at manned or unmanned stations.

Currently, procedures are based on preventative maintenance, which requires scheduled checks and adjustments to equipment on a routine basis. Frequent site visits are necessary, resulting in a labour intensive use of maintenance personnel. However, the application of remote maintenance monitoring techniques to some of the more isolated facilities is currently helping to reduce maintenance travel and some person years.

While the improved reliability of electronic equipment provides the potential for saving through the reduction of site visits, the unreliability of electrical power compromises efforts to achieve such savings. Basic electrical power is usually provided from a commercial source, but the possibility of failure requires that such prime power be backed up on-site by standby power systems. While steps are being taken now to improve the reliability and availability of electrical power and reduce maintenance, other possible means of providing prime and back-up power in the future are being investigated.

TRAINING

Most training of the operations and technical staff is carried out at the Transport Canada Training Institute (TCTI), Cornwall. Technical training includes instruction on computer-based systems, navigation aids, communications, radar systems, security systems, and aircraft avionics. Technical training, which is not carried out at TCTI, is provided through contracts, manufacturers courses, on-the-job training or field training programs. Similar training schemes are used in the training of ATC and FSS staff to qualify them in their areas of specialization. For controller training programs, considerable use is made of simulations both at TCTI and in the regions.

TECHNICAL SUPPORT

The Administration is responsible for the engineering development, design, procurement, maintenance and operation of all telecommunications electronics equipment and computer-based equipment for the Canadian Airspace System. Technical support is provided through three major facilities:

- An Engineering Systems Laboratory, which provides an environment for designing, developing and testing electronic devices and systems.

- A Development/Maintenance Centre (DMC), which provides field support to and configuration management of designated computer based systems in the field.

- A Research and Experimentation Centre (R & E Centre), which provides facilities to simulate and evaluate the work environment of air traffic controllers and thus provides the means for investigating new procedures and methods of controlling air traffic.

Various Management Information Systems are used to keep track of plant, as well as to provide management with both historical and day-to-day operational information relating to the performance of the Canadian Airspace System. Such information is vital for efficient management of the system and for conducting trend analysis relating to the maintenance of equipment. Presently there is no interrelationship between the various Management Information Systems in use and information is difficult to extract and correlate.

THE NEW APPROACH

FLIGHT INSPECTION

New flight inspection equipment and procedures will be used to increase the speed and efficiency with which facilities can be evaluated. The new Digital Flight Inspection System (DFIS) in conjuction with a Self-Contained Aircraft Positioning Equipment (SCAPE) will eliminate the need for ground support personnel during flight inspections and will provide a nearly weather-independent flight inspection capability. The equipment will record measurements and, because of the on-board computing capability, will be able to assess the results in-flight.

By the mid-eighties, the flight inspection fleet will consist of two high-speed and two medium-speed aircraft and the number of bases will have been reduced to two; one base being in Eastern Canada and the other in Western Canada. The slower turboprop aircraft will be used when low-level or repetitious measurements are necessary. Analysis has shown that the high speed aircraft, operating efficiently at higher altitudes and speeds, will enable the more distant and spread-out facilities to be inspected in less time and in fewer flights, while the use of turbo-prop aircraft, though slower, will effect savings in fuel.
The overall benefit of the new fleet plan will be lower costs and significant savings in fuel.

MAINTENANCE

Application of modern technology will change the procedures and methods of maintenance. The replacement of older tube-type equipment with new solid-state equipment will significantly reduce the maintenance workload. Additionally, the stability and predictable behaviour of solid-state equipment will enable maintenance procedures to be changed, from being based on regularly scheduled checks and adjustments, to being carried out only when the performance of the equipment degrades to predetermined limits. Both factors will reduce the amount of maintenance resources required.

A further approach to increasing the efficiency of the maintenance activity lies in the application of computer technology to extend remote control, monitoring and diagnostic appraisal of performance to most facilities in the Canadian Airspace System. The use of such Remote Maintenance Monitoring Systems (RMMS), in the future, will provide for the automatic monitoring and diagnosis of equipment from a central location. As a result, the need for maintenance travel will be further reduced and maintenance personnel will be consolidated into central locations.

To further reduce the need for site visits, emphasis must be placed on reducing the need for site and building maintenance and, where possible, arranging for any such maintenance to be done locally. Inherently more reliable sources of power, will be used. Diesel generators and other systems, that require frequent maintenance, will be replaced, where possible. These measures will further reduce the need for site visits and assist in consolidation of the workforce.

The full conversion to reliable solid-state equipment, revised maintenance policies and maintenance monitoring from central locations will significantly reduce operating costs, without incurring any degradation in service.

TRAINING

Computer Assisted Learning (CAL) techniques will be introduced as a means of enhancing the training of operational personnel. For example, CAL techniques will be used to keep maintenance staff up-to-date as the reliability of modern systems will reduce their exposure to a variety of maintenance situations. Similarily CAL techniques will be used to maintain the skill of operational personnel. While TCTI will remain as the focal point for training, the introduction of CAL will effect savings by reducing the need for travel and time away from the job. To minimise costs CAL packages will be specified and procured, as appropriate, as part of the contract in equipment procurement.

TECHNICAL SUPPORT

The need to provide engineering support, configuration management and to develop new procedures to accommodate the growth in systems will require more space than currently exists in the Engineering Laboratory, the DMC and the R & E Centre. Expansion and consolidation of the currently distributed facilities into a single establishment, the Technical Systems Centre, will enable common services and equipment to be shared and used more effectively.

The implementation of new maintenance procedures, based on performance monitoring, further emphasizes the need for a comprehensive Management Information System. By incorporating an historical data base, trend analysis will be used to predict system failures, improve equipment design, maintenance procedures and methods.

HOW THE SYSTEM WILL EVOLVE

NEAR TERM (TO 1985)

While the current flight inspection activity will continue during this period, the DFIS/SCAPE flight inspection equipment will be procured. New flight inspection methods and procedures, for use with this equipment will be established. The increasing use of solid state equipment will speed the change-over to performance based maintenance allowing corresponding reductions in maintenance and travel time. Small battery back-up power units will be installed at remote VHF/UHF radio peripheral stations to improve the reliability of these stations. Investigations into improving the reliability and availability of power systems will be undertaken. The specification for a Remote Maintenance Monitoring System (RMMS) will be completed and policies and standards developed to ensure the compatibility of all new or replacement equipment with RMMS.

INTERMEDIATE TERM (TO 1990)

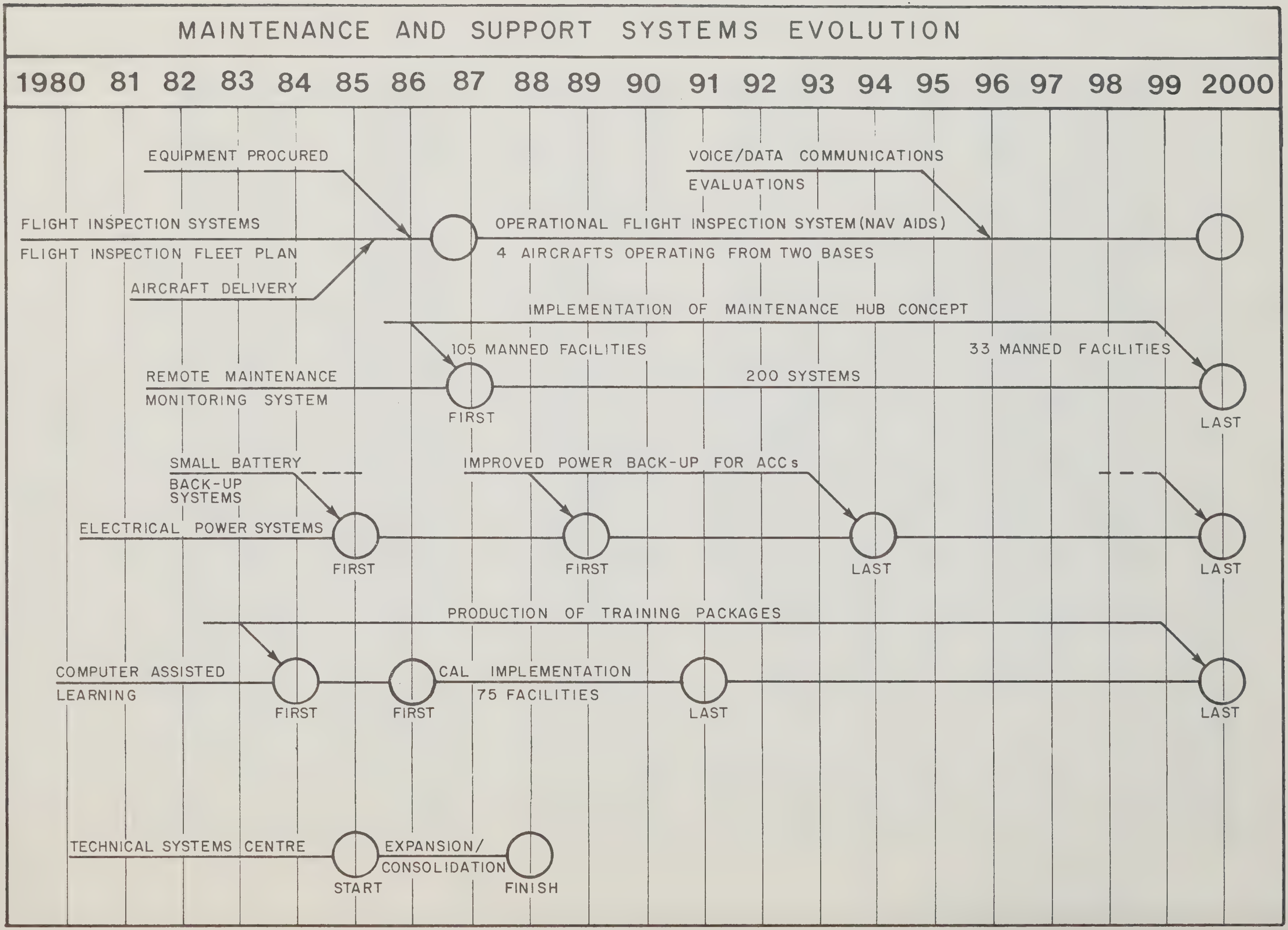
The new procedures and methods for flight inspection will be implemented. The number of flight inspection aircraft will be reduced to four and the number of bases to two. The introduction of RMMS, together with improvements to the reliability and availability of power systems, will allow the consolidation of the maintenance workforce and the establishment of consolidated maintenance centres.

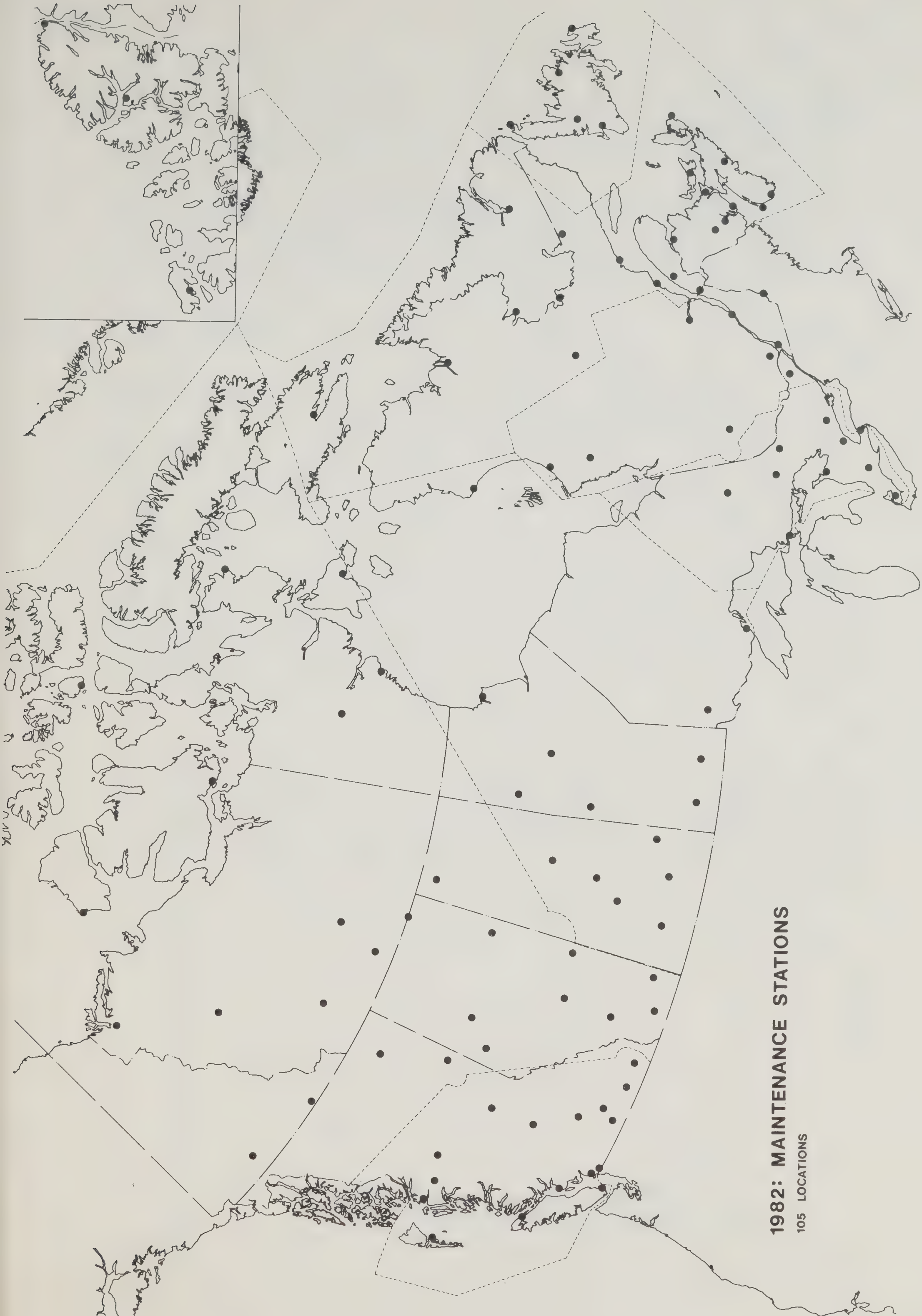
The technical support of the many new systems will require the establishment of a Technical Systems Centre to consolidate the Engineering Systems Laboratory, DMC and R & E Centre. The need to provide a means of enhancing the training of operational personnel will see the introduction of Computer Assisted Learning methods. A new Management Information System will provide improved inventory control and assessment of system perfomance in the field for equipment maintenance purposes.

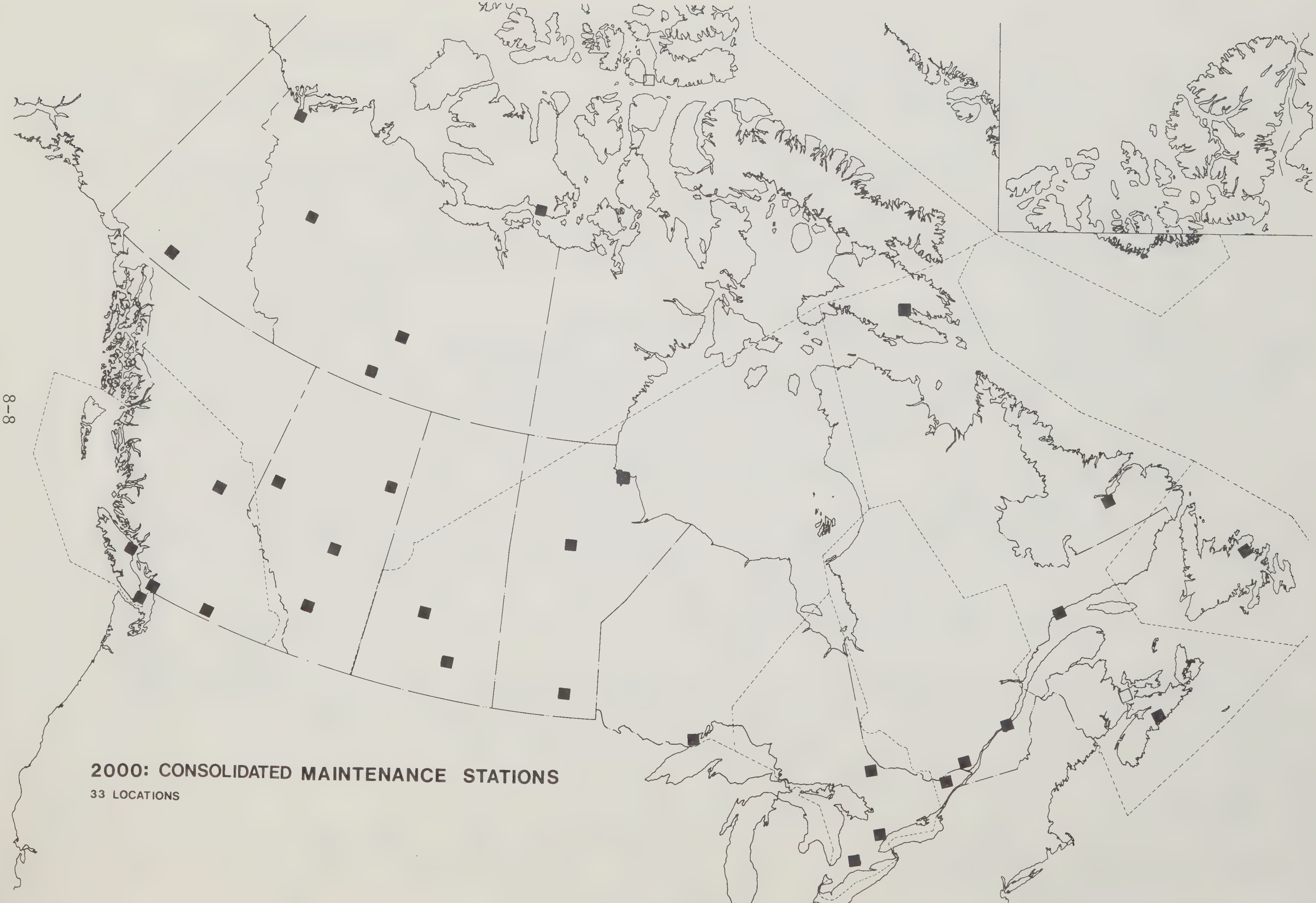
LONG TERM (TO 2000)

Flight inspection activities will be expanded to evaluate the performance appraisal of voice and data communications. Equipment to measure radio spectrum interference will be added to the aircraft in response to the increasing pollution of the radio spectrum. Data from flight inspections will be fed into the Management Information System to enhance the basis for trend analysis of system performance.

Most field maintenance personnel will be located at centrally manned stations. The RMMS will be used to monitor, test and control facilities at remote sites. The Management Information System will be used to monitor the long term performance of the Canadian Airspace System. The application of trend analysis will be used to update procedures and methods to ensure that maintenance is carried out in the most efficent and effective manner.


MAINTENANCE AND SUPPORT SYSTEMS EVOLUTION
1980 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000
EQUIPMENT PROCURED
VOICE/DATA COMMUNICATIONS
EVALUATIONS
FLIGHT INSPECTION SYSTEMS
FLIGHT INSPECTION FLEET PLAN
OPERATIONAL FLIGHT INSPECTION SYSTEM (NAV AIDS)
4 AIRCRAFTS OPERATING FROM TWO BASES
AIRCRAFT DELIVERY
IMPLEMENTATION OF MAINTENANCE HUB CONCEPT
105 MANNED FACILITIES
33 MANNED FACILITIES
REMOTE MAINTENANCE
MONITORING SYSTEM
200 SYSTEMS
FIRST
LAST
SMALL BATTERY
BACK-UP
SYSTEMS
IMPROVED POWER BACK-UP FOR ACCs
ELECTRICAL POWER SYSTEMS
FIRST
FIRST
LAST
LAST
PRODUCTION OF TRAINING PACKAGES
COMPUTER ASSISTED
LEARNING
CAL IMPLEMENTATION
75 FACILITIES
FIRST
FIRST
LAST
LAST
TECHNICAL SYSTEMS CENTRE
EXPANSION/
CONSOLIDATION
START
FINISH


1982: MAINTENANCE STATIONS
105 LOCATIONS



2000: CONSOLIDATED MAINTENANCE STATIONS

33 LOCATIONS

BENEFITS OF THE PLAN

The widespread utilization of highly reliable solid-state equipment, together with modern computer and communications technology will enable significant savings to be made in O and M costs to the year 2000.

Improved procedures and methods of operating the maintenance and support systems will result in a more efficient use of available resources, a consolidation of operations and a reduction in the need for staff. By the year 2000, as a result of the implementation of the plan, staff requirements will have increased by about 10% from the 1981 requirements.

SUMMARY OF CHANGES

FLIGHT INSPECTION

The reduction in the number of aircraft and the consolidation of bases will result in a staff reduction from 85 persons to 35 persons between 1985 and the year 2000.

MAINTENANCE

Currently 1350 personnel are employed carrying out field maintenance as well as administrative and technical support duties directly related to maintenance. By 1985, 1780 personnel will be required. Introduction of RMMS and the consolidation of maintenance stations, between 1989 and the year 2000, will retard growth requirement with only 1800 personnel being required in the year 2000.

TRAINING

While TCTI will remain as the focal point for training, the introduction of Computer Aided Learning will reduce the need for travel and time away from the job. The use of CAL in the field will keep maintenance and operational staff up-to-date, as the reliability of modern systems will reduce their exposure to system failures.

Implementation of CAL will start in 1986 and be in widespread use by 1991.

PROGRAM	IMPLEMENTATION 1st	IMPLEMENTATION Last
FLIGHT INSPECTION		
1. Flight Inspection Systems	1985	1987
2. The Flight Inspection Fleet Plan	1984	1987
MAINTENANCE		
3. Electrical Power Systems (Primary & Standby)	1985	2000
4. Remote Maintenance Monitoring Systems	1987	2000
TRAINING		
5. Computer Assisted Learning	1986	1991
TECHNICAL SUPPORT		
6. Technical Systems Centre	-	1988

PROJECT: FLIGHT INSPECTION SYSTEMS

PURPOSE: To implement an automated all-weather flight inspection system in order to increase the efficiency of flight inspection and improve the quality of the measurements.

APPROACH: The project will be carried out in two complementary sub-projects.

The first will be the development of a Digital Flight Inspection System (DFIS), having an on-board capability to digitize and record measurement data, automatically calculate the navaid parameters and provide an evaluation of the facility being measured. DFIS can operate both with theodolite measurements from the ground and with the highly accurate positioning system being developed as described below.

The second will be the development of a Self-Contained Aircraft Positioning Equipment (SCAPE), with a highly accurate positioning capability for the flight inspection aircraft. SCAPE will eliminate the need for theodolite tracking and the associated personnel. The combination of DFIS and SCAPE will provide a weather independent flight inspection capability. The capability of these systems to record and rapidly assess results will be implemented in the new flight inspection fleet in 1985/86.

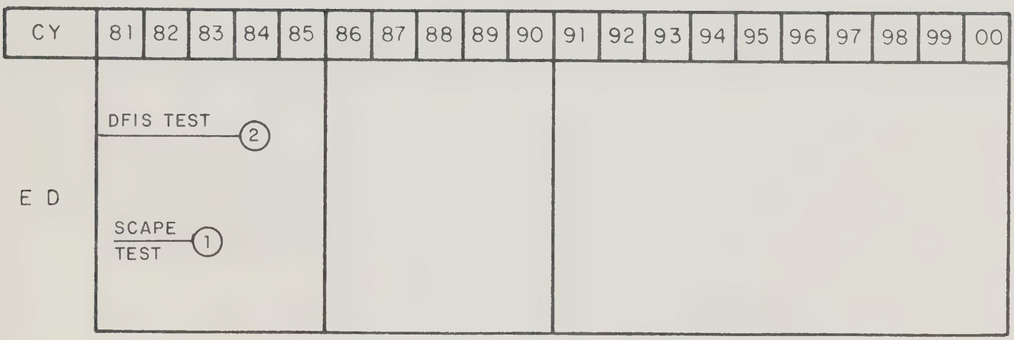
A preproduction DFIS is presently undergoing test in an Ottawa based aircraft. The feasibility of SCAPE has already been demonstrated.

QUANTITIES: Five sets of DFIS/SCAPE equipment will be procured.

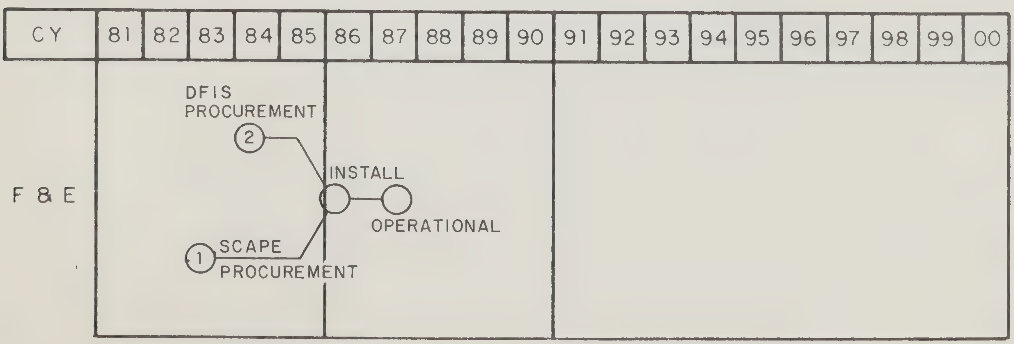
RELATED PROJECTS/ACTIVITIES:

- The Flight Inspection Fleet Plan.

SCHEDULE



SCHEDULE



PROJECT: THE FLIGHT INSPECTION FLEET PLAN

PURPOSE: To acquire modern fuel efficient aircraft and consolidate flight inspection bases.

APPROACH: The present aircraft fleet will be utilised for the flight inspection program up until 1985. Beyond 1985, the introduction of DFIS/SCAPE into the new flight inspection aircraft will enable a reduction in the number of aircraft and bases. Two different types of aircraft will be used. Jet aircraft, operating efficiently at higher altitudes and speeds, will enable the more distant and spread-out facilities to be inspected in less time and in fewer flights. The use of turbo-prop aircraft will be more efficient in low altitude work and provide more flexibility in inspecting certain facilities. Concurrent with these changes a restructuring of the operational flight inspection organization and methods of operation will be undertaken.

QUANTITIES: Two high speed and two medium speed aircraft. One of each type of aircraft to be based at each of two bases; one base in Eastern and the other in Western Canada.

RELATED PROJECTS/ACTIVITIES:

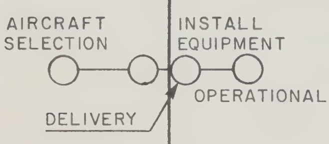
- Flight Inspection Systems.

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
E D																				

SCHEDULE

CY	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
F & E																				



PROJECT: ELECTRICAL POWER SYSTEMS (PRIMARY AND STANDBY)

PURPOSE: To improve the reliability and availability of elecrical power systems. In view of the high reliability of the other equipment, electrical power is now a weak link in the performance of many systems. The reliability and availability of electrical power must be improved and the need for maintenance of the electrical power systems reduced, prior to consolidation of the maintenance workforce. An availability study has shown that loss of power to equipment contributes to 90% of system outages.

APPROACH: Large back-up power requirements, such as in Area Control Centres (ACCs), are currently backed up by complex emergency power units, which are maintenance intensive and prone to failure. An investigation of such power systems will be undertaken to reduce complexity and improve reliability and availability. Small back-up power requirements can be readily made more reliable by the installation of Static Uninterruptible Power Units (SUPUs) which provide a battery based DC power supply in the event of power failure.

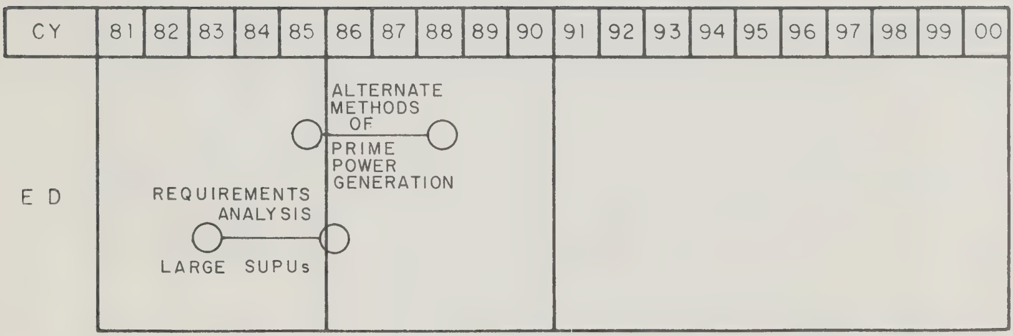
The provision of primary power, other than that provided by public utilities, is an area of great importance. The use of air cooled rather than liquid cooled diesels, for example, has been shown to significantly reduce diesel generator maintenance requirements and the use of distributed DC power, on site, can greatly simplify back-up power arrangements. The reduction of power requirements in many areas, due to the use of solid state equipment, has opened the door to other highly reliable sources of prime power. Such sources, for example, include solar arrays used in conjunction with rechargeable batteries, as well as water-activated disposable batteries cocooned in insulation with built-in heating capability, which can provide reliable power for a year or more at remote sites.

QUANTITIES: At the present time, 100 SUPUs are being procured to support Air/Ground communications equipment. These will be installed by 1985. The procurement of larger SUPUs will depend on the outcome of the requirements analysis completed in 1985.

RELATED PROJECTS/ACTIVITIES:

- None.

SCHEDULE



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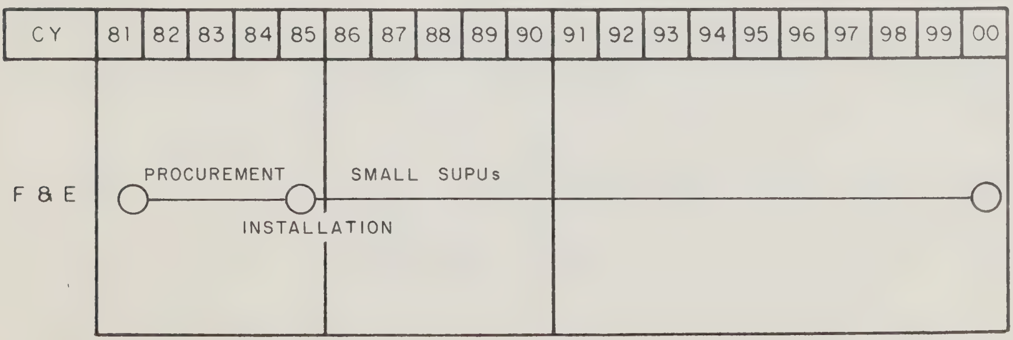


PROJECT: REMOTE MAINTENANCE MONITORING SYSTEM (RMMS).

PURPOSE: To provide a system capable of monitoring and controlling remote equipment, from a central location. The system will reduce staffing requirements, improve work force efficiency, reduce the amount of on-site test equipment and spare parts and be instrumental in bringing about consolidation of the maintenance personnel into centrally manned stations. The long-range goal is to develop, a standard RMMS that can be universally used.

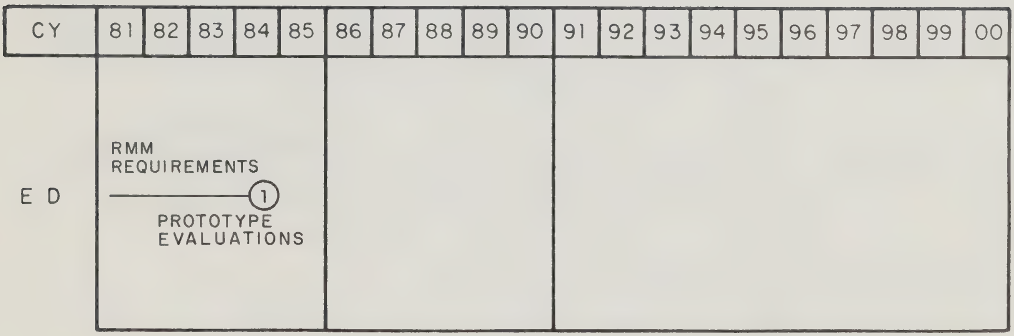
APPROACH: The RMMS will consist of a telemetry/controller at the remote end linked through local network facilities to interface units on the equipment to be monitored/controlled. The telemetry/controller will be linked through the interfacility network to a monitoring position in the central maintenance station.

QUANTITIES: Approximately 2000 maintenance sites will be remoted back to central maintenance locations. The first system will be installed in 1987.

RELATED PROJECTS/ACTIVITIES:

- Consolidation of manned maintenance stations.

SCHEDULE



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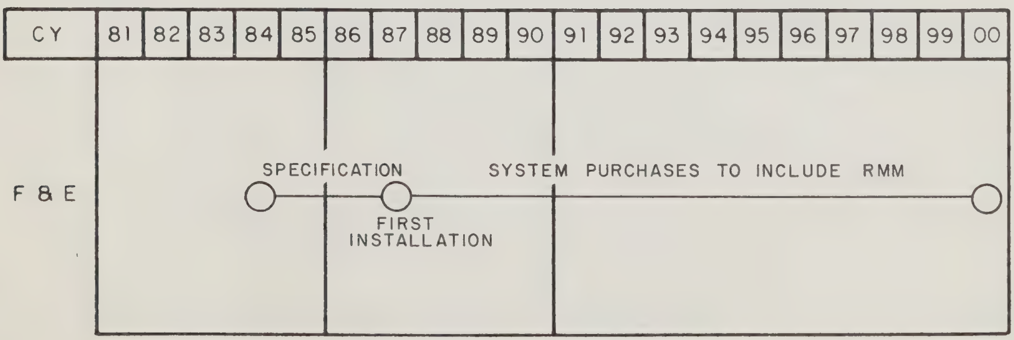


PROJECT: COMPUTER ASSISTED LEARNING (CAL)

PURPOSE: To introduce CAL as a means of providing a cost-effective, high quality method of training operational and technical personnel. The use of computer assisted learning is one of the methods to be used to reduce training costs. It will be closely associated with specific equipment and simulation training at the Transport Canada Training Institute (TCTI) resulting in:

- Significantly reduced travel costs associated with traditional training.
- Flexibility necessary for student self-pacing.
- Nation wide standardization of training course material.
- Rapid dissemination of development, refresher, and state-of-art training modules.
- Improvements in employee productivity resulting from higher levels of skill and knowledge.

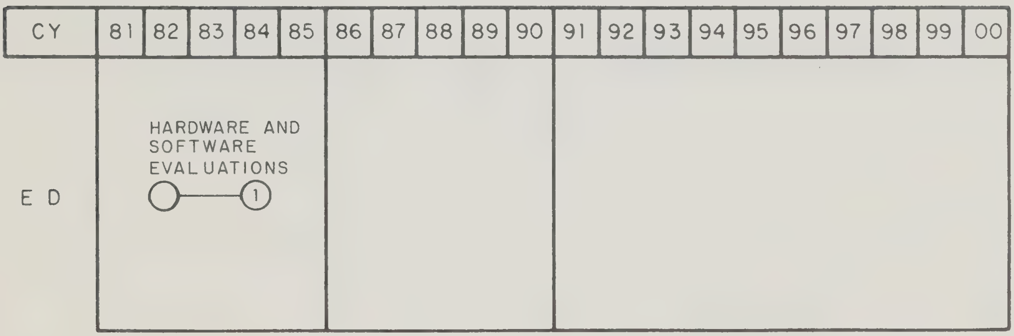
APPROACH: To establish CAL terminals at the major facilities, such as regional offices, manned maintenance sites, FSS hubs, ACCs, and TCU's, as well as at TCTI. The project will consist of two phases. In the first, research and development will be carried out to evaluate CAL software and hardware in order to determine cost-effective methods of course production and delivery. On an on-going basis, to minimise costs, CAL packages will be specified and procured, when appropriate, as part of the contract in equipment procurement. In the second, training packages will be produced.

QUANTITIES: Implementation will provide for the establishment of CAL in about 75 facilities. Present training courses will be converted to CAL when justified on a cost-effective basis.

RELATED PROJECTS/ACTIVITIES:

- Controller Training and Proficiency Evaluation Simulation Systems.

SCHEDULE



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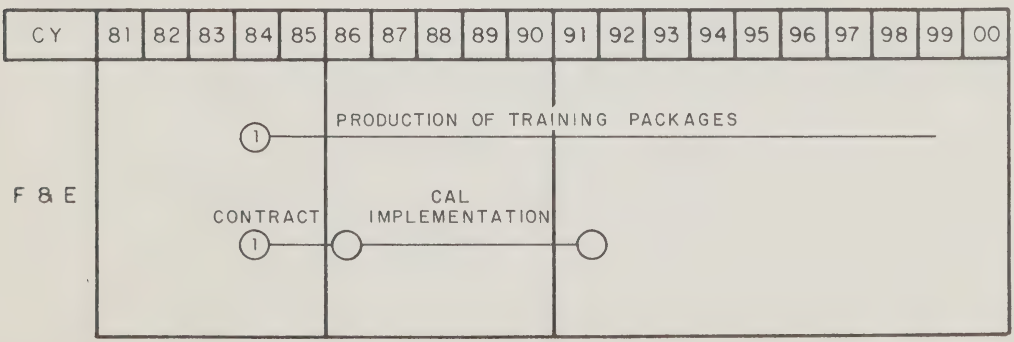


PROJECT: TECHNICAL SYSTEMS CENTRE (TSC)

PURPOSE: To establish a Technical Systems Centre to provide the necessary laboratory and office space to accommodate the growth in technical support needs of the Canadian Airspace System.

APPROACH: The need to provide engineering support, configuration management and to develop new procedures to accommodate the growth in systems will require more space than currently exists in the Engineering Systems Laboratory, the DMC and the R&E Centre. At the present time these facilities provide a combined total of 5500 square meters of laboratory and office space. Growth predictions have established a requirement for 8000 square meters by 1988. Expansion and consolidation of the currently distributed facilities into a single establishment, the Technical Systems Centre, will:

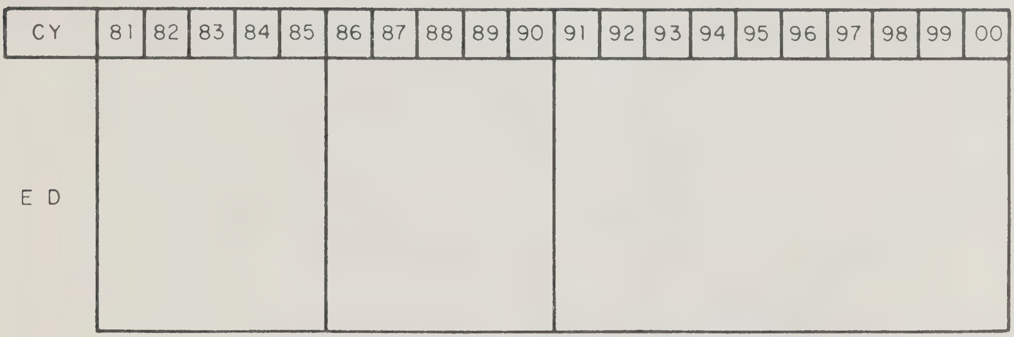
- Ensure future laboratory and office space requirements are met.
- Enable common services and equipment to be shared and used more effectively.

QUANTITIES: Projected requirements are for a net usable floor space comprising 5800 square meters of laboratory space and 2200 square meters of office space.

RELATED PROJECTS/ACTIVITIES:

- Research and Experimentation System Enhancements.

SCHEDULE



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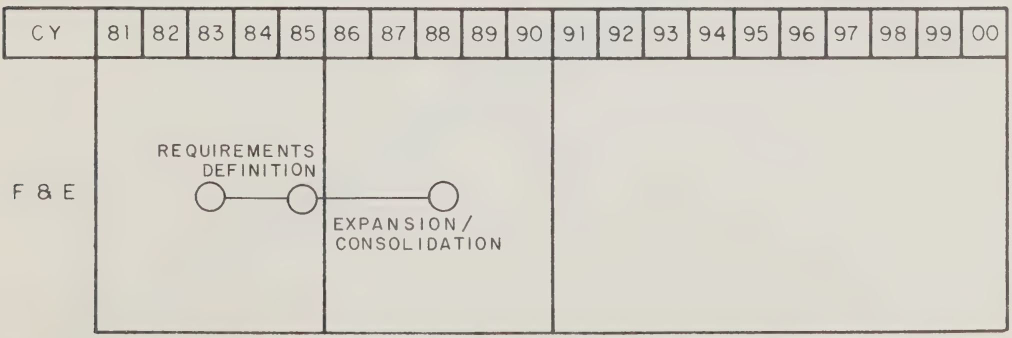

GLOSSARY

GLOSSARY

AIR-GROUND COMMUNICATIONS - Refer Chapter 6

VHF - Transmission of voice or data via VHF frequencies (e.g. 121.5 MHz) between ground stations and aircraft. VHF Communications are used by civil aviation.

UHF - Transmission of voice or data via UHF frequencies (e.g. 243 MHz) between ground stations and aircraft. UHF communications are used by military aircraft.

HF - Transmission of voice or data via HF frequencies (e.g. 5680 kHz). HF frequencies are used by civil aircraft. Since HF does not require line of sight between the aircraft and the ground station (as does VHF) it is useable at greater ranges and lower altitudes.

AIRPORT SURFACE DETECTION EQUIPMENT (ASDE) - Refer Chapter 6

An airport surface surveillance radar system used to detect and display the presence and position of aircraft and vehicles on the airport surface.

AIRPORT SURFACE NAVIGATION SYSTEM - Refer Chapter 6

A proposed high resolution localized navigation system for use by vehicles and aircraft on the manoeuvring area of airports during low visibility conditions. The system will use existing departmental transmitters, (for the most part) and makes phase measurements between various signals to calculate the vehicle position. It may also be used to direct emergency vehicles to accident locations on or in the vicinity of an airport.

Laboratory tests, to date, indicate position fixes in the order of one metre may be achievable.

AUTOMATED WEATHER OBSERVING AND REPORTING SYSTEM (AWORS) - Refer Chapters 4, 5

This system, through the use of remote sensors, will automatically "observe" and report actual weather such as ceiling, visibility, precipitation, barometric pressure and wind velocity. The implementation and operation of these systems will improve FSS productivity, support consolidation of FSS facilities and provide an improved weather data base to support more accurate forecasting.

CANADIAN AERONAUTICAL DIGITAL NETWORK (CADIN) - Refer Chapter 7

An Integrated Common User Communications Network with virtual circuit and alternate routing capability. The existing ADIS Network will be replaced to form the basic network with gradual integration of existing and proposed data systems and eventually the integration of digitized voice systems. The network will be code and byte independent.

COMPUTER ASSISTED LEARNING (CAL) - Refer Chapter 8

The use of computer assisted learning packages as a cost-effective high quality method of training operational and technical personnel.

DEPENDENT SURVEILLANCE - Refer Chapters 3, 6

The automatic transfer of aircraft positional data in four dimensions (latitude, longitude, altitude, time) derived from the on-board navigation systems, using air to ground data-link.

DIFFERENTIAL OMEGA - Refer Chapter 6

The world-wide OMEGA system accuracy in localized areas can be enhanced by differential techniques. The principle of Differential OMEGA consists in observing the difference between the actual and predicted phases at a known position with an OMEGA receiver; transmitting (by modulating the tone on an NDB) the observed corrections in real-time to all users operating in the localized area; and applying the received corrections to the receiver used on board the aircraft.

DIGITAL FLIGHT INSPECTION SYSTEM (DFIS) - Refer Chapter 8

An automated airborne data collection and processing system which reduces flight inspection workload and flight time. Aircraft position data and received navigational data from VOR, INS, MLS etc. is collected by DFIS, analyzed against required standards and required reports are automatically produced on completion of the flight inspection.

DIRECT USER ACCESS TERMINAL (DUAT) - Refer Chapters 4, 5

A computer terminal which can be used to input flight plans and to access pre-flight information such as weather and NOTAM.

DISTANCE MEASURING EQUIPMENT (DME) - Refer Chapter 6

A UHF navigation aid which provides continuous distance information to and from the DME location. The DME is usually colocated with the VOR so that both azimuth and distance can be determined with reference to the VOR-DME. Overall accuracy of DME is in the order of $\pm 1/4$ NM.

EN-ROUTE WEATHER ADVISORY SERVICE (EWAS) - Refer Chapters 4, 5

A weather advisory service to provide a timely exchange of aviation weather information with enroute aircraft. This service is provided by FSS weather briefing personnel on a dedicated VHF frequency.

GANDER AUTOMATED AIR TRAFFIC SYSTEM (GAATS) - Refer Chapter 3

A computerized flight data processing system for oceanic traffic which performs prediction of potential conflict between flights, generation of printed flight data strips with time estimates based on a weather model, development of minimum time tracks, and automatic data interchange with the oceanic centre in Prestwick, Scotland.

GANDER AUTOMATED FLIGHT SERVICE STATION (GAFSS) - Refer Chapter 4

Automation of in-station handling of air-ground messages and related flight information processing at the Gander International Flight Service Station.

INSTRUMENT LANDING SYSTEM (ILS) - Refer Chapter 6

A VHF navigation aid providing approach and landing guidance to the runway. The localizer (LOC) portion provides runway centre line guidance in the horizontal plane while the glide path (GP) provides descent guidance (normally 3°) in the vertical plane. Usually, two VHF markers (middle and outer) provide distance checks at precise distances from the runway approach end. In some cases DME is provided instead of the VHF markers. The LOC or a combination of LOC-DME is sometimes installed for track guidance or non-precision approach guidance.

INTEGRATED COMMUNICATIONS CONTROL SYSTEM (ICCS) - Refer Chapter 3

A computerized communications system which integrates all voice communications facilities, including radio, hotline, interphone and telephone communications. The control and switching system utilizes frequency division multiplexing, where the information on each voice circuit is carried on a discrete radio frequency channel. The processor controls the channel assignment and routes the voice paths by selectively changing channel assignments at the operating positions.

JOINT EN ROUTE/TERMINAL SYSTEM (JETS) - Refer Chapter 3

A computerized system for the processing and display of Secondary Surveillance Radar (SSR) data. The system performs radar data tracking on data from up to 8 radars, provides flight plan-to-track correlation and displays target information (up to 32 displays) including present position and history trails, aircraft call sign, speed and altitude.

LOCAL AREA NETWORK (LAN) - Refer Chapter 7

A data communications network serving a limited geographical area (e.g. an Area Control Center) which allows a number of independent systems to communicate with each other, sharing information and computer-related resources.

LORAN "C" - Refer Chapter 6

Loran "C" is an LF radio navigation system which uses time-synchronized pulsed signals from ground transmitting stations spaced several hundred miles apart. The stations are configured in chains of three-to-five stations which transmit with the same pulse group repetition rate. Within each chain, one station is designated as master and the remainder as secondaries. In the normal configuration, aircraft position is derived by measuring the difference in arrival time of the master's pulses and pulses from two secondaries or three secondaries. For purposes of area navigation, aircraft latitude and longitude are derived from several time differences and averaged.

LOW-LEVEL VORTEX WARNING ALERT SYSTEM (LLVWAS) - Refer Chapter 5

A system for detecting vorticies created by aircraft during landings and takeoffs. One promising technique in the early developmental stage is the utilization of a continuous wave (as opposed to pulsed) radar using a frequency sweep technique for obtaining wind velocity and range data.

LOW LEVEL WIND SHEAR ALERT SYSTEM (LLWAS) - Refer Chapter 5

A computerized system which determines the presence of wind shear in the operating environment by calculating the difference between the speed and direction of wind at a number of points around an airport, and comparing the values with those existing at a point near the centre of the airport. The location and intensity of the wind shear is provided on a display to the controller.

MICROWAVE LANDING SYSTEM (MLS) - Refer Chapter 6

A navigation aid providing precision approach and landing guidance to the runway. The MLS incorporates an azimuth (AZ) installation, an elevation (EL) installation and a precision distance measuring equipment (DME-P). The MLS is the future ICAO standard approach and landing system which is expected to be in widespread use by 1995. It offers advantages over ILS. It is adaptable to a broader range of airport conditions and provides precise navigation in the horizontal plane off the centre-line of the runway and providing selectable descent angles. It therefore has greater operational flexibility catering to a wide range of aircraft and providing the potential for improved air traffic operating efficiencies.

NATIONAL FLIGHT DATA PROCESSING SYSTEM (NFDPS) - Refer Chapter 3

A computerized system that automates the printing of flight data strips.

NON-DIRECTIONAL BEACON (NDB) - Refer Chapter 6

An LF navigation aid providing an omni directional signal allowing an airborne receiver to determine the direction to the NDB location. When coupled with the airborne magnetic compass the bearing to the NDB can be determined. The overall accuracy of the NDB is in the order of 10°.

OMEGA - Refer Chapter 6

Omega is a radio-navigation system operating in the 10 to 14 kHz VLF frequency band with an accuracy of 2-4 nautical miles. It consists of eight worldwide transmitters producing phase coherent signals. Since VLF signals propagate in a stable and predictable manner over long paths, a receiver can determine its position by phase measurement of these signals.

The two common methods of position fixing are hyperbolic and rho-rho.

(1) Hyperbolic (requires at least 3 stations) - The phase of two transmitted signals is compared to give a line of position (LOP). This LOP is hyperbolic in shape. By using a third transmitter, another LOP can be determined and the receiver is located where the LOPs intersect.

(2) Rho-Rho (requires at least 2 stations) - The phase of one transmitter is compared to a precision phase reference on board the aircraft. This gives a circular line of position about the transmitter. By using another transmitter, a second LOP can be determined and the aircraft is located where the LOPs intersect.

OPERATIONAL INFORMATION DISPLAY SYSTEM (OIDS) - Refer Chapter 3

A computerized system that collects data on environmental conditions such as wind direction and speed, weather, runway visual range and other aviation related conditions such as serviceability of navigation aids and runway status. The data is processed and displayed in a convenient format to air traffic controllers to assist them in providing advisory services to users.

PRIMARY SURVEILLANCE RADAR (PSR) - Refer Chapters 3, 6

A surveillance system usually operating in the L or S frequency band which transmits electromagnetic pulses into space and receives energy reflected. Range and azimuth of aircraft are determined from the round trip time of the signal and pointing angle of the antenna respectively.

REMOTE COMMUNICATIONS OUTLET (RCO) - Refer Chapter 4

A transmitter/receiver system operated by remote control from a manned "HUB" Flight Service Station. The RCO extends the VHF radio services of the base station.

REMOTE MAINTENANCE MONITORING SYSTEM (RMMS) - Refer Chaper 8

A system of monitoring and controlling equipment remotely from a central location which will improve the productivity of maintenance personnel and support the consolidation of manned maintenance centers. Remote monitoring subsystems will be linked locally through LAN techniques and remotely to centralized monitoring positions via CADIN.

RUNWAY VISUAL RANGE (RVR) - Refer Chapter 6

Is a computed visibility value representing the minimum expected distance a pilot should be able to see along the runway based on his sighting of runway markers or lights at prevailing intensity settings. The RVR system is comprised of the transmissometer and the RVR computer. The transmissometer is located adjacent to the runway to measure ambient transmissitivity while the RVR computer converts the transmissometer output into visibility in units of feet.

SECONDARY SURVEILLANCE RADAR (SSR) - Refer Chapters 3, 6

A surveillance system transmitting at 1030 MHz and receiving at 1090 MHz. The radar transmits coded pulse pair interrogations which are received by a transponder on board an aircraft. The pulses are decoded and a reply pulse code train is transmitted back to the interrogating station. Range and azimuth are determined in a similar fashion to PSR, while identification code and altitude of the aircraft are decoded from the reply pulse code trains.

SECONDARY SURVEILLANCE RADAR MODE S (SSR MODE S) - Refer Chapters 3, 6

A technique using a unique discrete address for each aircraft, that is compatible with existing SSR systems, and enabling an air-ground data link. A further description is available in ICAO Circular 174-AN/110.

SELF-CONTAINED AIRCRAFT POSITIONING EQUIPMENT (SCAPE) - Refer Chapter 8

A precision airborne aircraft positioning system which permits flight inspection of landing systems (ILS and MLS) to Category II accuracy standards in poor visibility conditions and without ground tracking of the aircraft. The airborne equipment automatically senses accurately positioned light sources on the ground in the vicinty of the runway and uses this information to update an INS and improve the error prediction modelling of the aircraft predicted position. The system also provides aircraft position for enroute flight inspection using multiple or single DME updating of the INS and has a manual mode which allows landing systems to be inspected to a lower accuracy. SCAPE, when combined with DFIS provides for a fully automated, all weather flight inspection capability.

TACTICAL AIR NAVIGATION (TACAN) - Refer Chapter 6

A UHF navigation aid providing both azimuth and distance to and from the TACAN location. The TACAN is utilized by the military; but the distance feature of TACAN is equivalent to DME and is useable by civil aviation. For civil aviation application a colocated VOR and TACAN installation is equivalent to VOR-DME.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) - Refer Chapter 3

An airborne collision avoidance system based on the processing of SSR transponder replies (both existing SSR transponders and SSR Mode S transponders) from proximate aircraft. SSR Mode S data protocols are utilized for the communications functions of TCAS. TCAS capabilities range from a minimal warning system, designated in TCAS I, to a full capability traffic advisory and resolution advisory system, designated as TCAS II.

TRANSCRIBED WEATHER BROADCAST (TWB) - Refer Chapter 5

A pre-recorded continuous broadcast of the latest aviation weather and other aeronautical information. Broadcasts are transmitted over navigational aids, dedicated frequencies and can be accessed by the public telephone system.

VERY HIGH FREQUENCY DIRECTION FINDER (VHF-DF) - Refer Chapter 6

A VHF navigation aid which determines at the ground station the direction of the aircraft from the VHF-DF location. The VHF-DF senses the communications transmission from the aircraft and displays the aircraft's bearing to the air traffic controller or flight services specialist. It is used to assist pilots who are uncertain of their position and to assist ATS to locate aircraft visually or on radar presentation screens.

VERY HIGH FREQUENCY OMNI-RANGE (VOR) - Refer Chapter 6

A VHF navigation aid which provides continuous azimuth bearing information to and from the VOR location. This system is the international standard for enroute airway guidance having an overall accuracy in the order of $\pm 5°$.

VERY LOW FREQUENCY NAVIGATION (VLF NAV) - Refer Chapters 1, 6

In addition to the OMEGA transmitters operating in the VLF band, there are phase coherent VLF communications transmitters operated by the U.S. Navy which can be used for navigation.

To complement and improve the OMEGA signal coverage in Canada there has been a recommendation to consider the establishment of two Canadian VLF Navigation transmitters dedicated to navigation.

WEATHER RADAR - Refer Chapter 6

A weather surveillance system operating usually in C band frequency range, in a similar manner to Primary Surveillance Radar, where the amount of energy reflected by water particles in the atmosphere is proportional to their density, thus permitting the display of different levels of rainfall.